

#, 2

THE FROGS OF EASTERN
NEW SOUTH WALES

JOHN A. MOORE

BULLETIN
OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
VOLUME 121 : ARTICLE 3 NEW YORK · 1961

THE FROGS OF EASTERN NEW SOUTH WALES

THE FROGS OF EASTERN NEW SOUTH WALES

JOHN A. MOORE

Research Associate, Department of Herpetology

The American Museum of Natural History

Professor of Zoology

Barnard College and Columbia University

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME 121 : ARTICLE 3

NEW YORK : 1961

BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Volume 121, article 3, pages 149-386, text figures 1-74,
plates 27-46, tables 1-11

Issued March 27, 1961

Price: \$6.00 a copy

CONTENTS

INTRODUCTION	155
Materials and Methods	155
Criteria for the Recognition of Species.	157
Acknowledgments	161
THE FAMILY LEPTODACTYLIDAE.	162
<i>Mixophyes fasciolatus</i> Günther	162
<i>Cyclorana alboguttatus</i> (Günther)	166
<i>Lechriodus fletcheri</i> (Boulenger)	169
<i>Adelotus brevis</i> (Günther)	174
<i>Heleioporus australiacus</i> (Shaw)	179
<i>Neobatrachus pictus</i> Peters	183
<i>Limnodynastes dorsalis</i> (Gray)	187
<i>Limnodynastes ornatus</i> (Gray)	193
<i>Limnodynastes peroni</i> (Duméril and Bibron)	197
<i>Limnodynastes tasmaniensis</i> Günther	203
<i>Limnodynastes fletcheri</i> Boulenger	208
<i>Limnodynastes salmini</i> Steindachner.	210
General Remarks on the Genus <i>Limnodynastes</i>	212
<i>Kyarranus sphagnicolus</i> Moore	214
<i>Kyarranus loveridgei</i> (Parker)	216
<i>Uperoleia marmorata</i> Gray	219
<i>Crinia haswelli</i> Fletcher	224
<i>Crinia signifera</i> Girard	225
<i>Pseudophryne australis</i> (Gray)	235
<i>Pseudophryne bibroni</i> Günther	240
<i>Pseudophryne dendyi</i> Lucas	244
<i>Pseudophryne coriacea</i> Keferstein	247
<i>Pseudophryne corroboree</i> Moore	248
THE FAMILY HYLIDAE.	251
<i>Hyla bicolor</i> (Gray)	251
<i>Hyla phyllochroa</i> Günther	255
<i>Hyla caerulea</i> (White)	258
<i>Hyla chloris</i> Boulenger	263
<i>Hyla gracilentia</i> Peters	265
The Green Hylas	267
<i>Hyla peroni</i> (Tschudi).	268
<i>Hyla citropa</i> (Tschudi)	272
<i>Hyla dentata</i> Keferstein	275
The <i>Hyla ewingi</i> Complex	278
<i>Hyla jervisiensis</i> Duméril and Bibron	281
<i>Hyla ewingi</i> Duméril and Bibron	284
The Ground Hylas	291
<i>Hyla booroolongensis</i> , New Species	292
<i>Hyla lesueuri</i> Duméril and Bibron	294
<i>Hyla latopalmata</i> (Günther)	298
<i>Hyla freycineti</i> (Tschudi)	302
<i>Hyla nasuta</i> (Gray)	305
The <i>lesueuri</i> Complex	309
<i>Hyla aurea</i> (Lesson)	313

KEYS TO THE FROGS OF EASTERN NEW SOUTH WALES	323
Key to the Leptodactylids	323
Key to the Hylids	325
A SYNOPSIS LIST OF AUSTRALIAN AMPHIBIANS	328
NAMES APPLIED TO AUSTRALIAN AMPHIBIANS	332
GEOGRAPHIC DISTRIBUTION	356
Frogs of the Sydney Region	356
Frogs of New South Wales	356
Frogs of Queensland	357
Frogs of the Northern Territory	357
Frogs of Victoria	357
Frogs of Tasmania	358
Frogs of South Australia	358
Frogs of Western Australia	358
Patterns of Distribution	359
Zoogeographical Subregions	364
Conclusions	368
HYBRIDIZATION EXPERIMENTS	371
BIBLIOGRAPHY	374

INTRODUCTION

IN THE PRESENT REPORT the 37 species of Amphibia, belonging to the families Leptodactylidae and Hylidae, that are known to occur in New South Wales east of the Dividing Range are described. Although there is this geographical restriction for the species included, there is no geographical restriction on the information presented for each species. That is, if an eastern New South Wales species is found in other areas, the available data from the other areas are given.

Eastern New South Wales has an importance in Australian herpetology that far exceeds its proportionate area. About 40 per cent of the species of Australian frogs occur

here. It is, furthermore, the region that has been studied most extensively and over the longest period of time. It was the center of activity for most of the Australian herpetologists such as Krefft, Fletcher, Harrison, Fry, and Kinghorn. In addition, Krefft and Fletcher, as well as others, sent specimens of eastern New South Wales frogs to the British Museum where they were studied successively by Gray, Günther, Boulenger, and Parker. Lastly, the Australian Museum in Sydney has the finest collection of Australian amphibians in existence, and most of its specimens are from eastern New South Wales.

MATERIALS AND METHODS

The basis of this report is the information and specimens that I obtained during a year in Australia beginning in July, 1952. My work was made possible by a Fulbright Grant. Most of my field work was done in the Sydney area, especially near Killara. In addition, trips of short duration were made to the following localities: Canberra; Armidale, the Blue Mountains, Kosciusko, and the south coast of New South Wales; Olinda and the eastern portion of Victoria; Lake St. Clair in Tasmania; the McPherson Range, Gladstone, Mackay, Cairns, and Rainsby Station (near Aramac) in Queensland; Alice Springs in the Northern Territory; and various places between Morawa and Pemberton in Western Australia.

Field observations were made on 62 trips at night and 57 trips during the day. The greatest portion of my time was spent in the laboratory of the Zoölogy Department at Sydney University in studying the adults, tadpoles, and early embryos that I collected in the field. Numerous cross fertilization experiments were performed, as it was felt that the information obtained would aid in an understanding of the interspecific relationships.

Two months were spent in the Spirit House of the Australian Museum in studying the species included in the report, with the exception of *Limnodynastes ornatus* and *Hyla ewingi*.

The information for each species is arranged as follows:

COMMON NAME: The most widely accepted or most appropriate common names are used. I have coined names when suitable ones were not available.

DIAGNOSIS: The diagnosis indicates how the species can be distinguished from other species of frogs found in eastern New South Wales. It must be emphasized that the diagnosis has this geographical limitation. It may not be adequate for distinguishing a New South Wales species from species found in other parts of Australia.

DESCRIPTION: Except where otherwise indicated, the description of the form and coloration of the adult is based on living animals. Measurements were made with calipers on preserved specimens. Body length is the distance from the tip of the snout to the cloacal opening. Tibia length is the length of the tibial segment of the leg measured when the leg is flexed. Head length is the straight-line distance from the tip of the snout to the posterior end of the jaws. Head width was measured by adjusting the calipers to make a snug fit on the head at the posterior end of the angle of the jaws. The only measurements given are body length. The other measurements are used to determine these ratios: tibia length/body length, head width/head length, head length/body length. For each ratio the mean value, standard error of the

mean, and observed range of the individual values are given. Where the standard error is given as 0.00, its value is less than 0.005.

It should be noted that the ratios used are the reciprocal of those frequently employed in descriptions of frogs. There is a good reason for this change. The proportions most frequently used are the relative length of the tibia (or leg), the relative length of the head, and the relative width of the head. In the ratios that I am using the larger the part the larger the ratio. Thus, the longer the tibia, the greater will be the tibia length/body length ratio. If the reciprocal ratios had been used, an increase in the relative size of any of these parts would have led to a decrease in the ratio. The relative length of the fingers is determined by pressing the outstretched fingers together.

HABITAT: There is very little information in the literature on the places where Australian frogs are found. Most of the information that is given, therefore, is based on my field observations. Photographs of the habitats are provided for many of the species.

VOICE: I have followed the conventional and unsatisfactory method of describing frog calls by attempting to find words, or combinations of letters, that correspond to the sounds.

BREEDING HABITS: Most of this information is based on data from field observations in the Sydney area.

EMBRYONIC DEVELOPMENT: A special effort was made to study the development of as many species of leptodactylids as possible because there is so little information on this subject to be found in the literature. The embryos were obtained from natural spawnings or by artificial fertilization of uterine eggs. The identification of embryos and tadpoles collected in the field was always verified by raising them to metamorphosis. The stages used to describe development are those defined in Pollister and Moore (1937).

GEOGRAPHIC DISTRIBUTION: The specimens in the Australian Museum, together with those in the American Museum of Natural History, provide considerable data on geographic distribution. My own collection of nearly one thousand specimens is part of the American Museum of Natural History collection; they bear catalogue numbers

higher than 58862. The localities where the specimens were obtained are listed by state and, within each state, from north to south. Locality records mentioned in the literature are given only if they are places other than those represented by specimens, and only one reference is cited for each locality. A map showing geographic distribution is given for each species. Localities represented by specimens are shown as large dots; localities mentioned in the literature are shown as circles with a small dot in the center. The localities mentioned in the text and preceded by an asterisk are not shown on the map, either because they could not be found or were poorly localized ("Cape York"), or because there were two localities with the same name in one state.

COMMENTS: This is a "catch-all" heading. Comments on the systematics, relations to other species, points of exceptional interests, and special problems are given here.

LITERATURE: An effort has been made to list all the serious literature for each species and to indicate briefly the scope of each reference. When an author has used other than the currently accepted name for a species, the fact is mentioned.

Following the descriptions of the individual species are several sections containing general information. First, there are keys for the identification of the Leptodactylidae and the Hylidae of eastern New South Wales. A synoptic list (as table 9) of all the species of Australian frogs appears next. It was thought desirable to include this for two reasons. First, there is no modern list of the Australian frogs, and, second, in the discussions of New South Wales frogs there were so many references to species not occurring in this state that it was necessary to give a synopsis of the entire fauna for reference. The section following consists of a list of all the names that have been applied to Australian frogs, together with the current status of these names. In an effort to make this list as useful as possible, the names are arranged alphabetically, not under the currently accepted species as is the usual practice in systematics.

The next section deals with geographic distribution. Here again, the primary purpose has been to assemble data. Lists of species have been prepared for all the states. It will

be possible, therefore, for a student to ascertain if any of his specimens significantly extends the range of a species.

The last section lists the crosses that I made among the various species of Australian frogs.

CRITERIA FOR THE RECOGNITION OF SPECIES

In order that the reader may be able to evaluate my taxonomic treatment of the various species, it seems appropriate that I state my understanding of the nature of species in frogs. In practice, systematics is a subjective art, and we still follow Darwin's (1859) advice that in "... determining whether a form should be ranked as a species or a variety, the opinion of naturalists having sound judgment and wide experience seems the only guide to follow." It is, however, as difficult to recognize a naturalist with sound judgment as it is to recognize a "good" species. Some of the difficulty can be avoided by my listing the criteria that are used for the species category.

I do not doubt for one moment that the systematist's category "species" has a counterpart in nature. A species, in frogs, has the following characteristics:

1. The individuals of a species that occur in the same region resemble one another closely in morphological, physiological, and behavioral characteristics as well as in the habitats they occupy.

2. The intragroup resemblances among members of the same species are usually greater than the resemblances to the individuals of other species that live in the same region.

3. Within a species there are no genetic mechanisms that prevent interbreeding between sympatric individuals of the opposite sex and the production of normal offspring.

4. Under natural conditions, the individuals of one species rarely interbreed with individuals of other species. This does not mean that hybridization is impossible in experimental situations. There are many cases where individuals that belong to two species, as evidenced by their behavior in nature, can be crossed experimentally and can produce seemingly normal offspring. On the other hand, if individuals of two different sympatric groups are unable to cross and produce normal offspring in nature and in the laboratory, they are different species.

For reasons that are discussed below, these criteria apply primarily to taxonomic situations that are easily determined, i.e., to sympatric species. When one attempts to decide whether or not two allopatric populations belong to the same species, the difficulties encountered are much greater.

These criteria that serve as our "yardstick" in defining species are of two sorts. Criteria 1 and 2 pertain to structure and habits, whereas criteria 3 and 4 pertain to the ability or inability freely to exchange genetic materials. We are employing a double standard, which may lead to a double answer. In those instances in which the two standards give different answers, the answer obtained from the genetic criteria is used.

It might be added, parenthetically, that it is probably easier to apply this biological species concept to frogs than to any other group of vertebrates. They are perhaps the easiest of all vertebrates to study in the field, where their breeding habits can be observed. The techniques for handling their gametes are relatively simple and of easy execution. As it is feasible to apply the biological species concept to frogs, this group could serve as a test project in a newer systematics. It is not implied, however, that this report is such a project.

The major problem in systematics is to decide whether two similar individuals or groups of individuals belong to one species or to two. It is not always possible to answer this question even when there is an abundance of material. It is necessary, therefore, to explore the various possibilities that can be realized and to suggest how a solution may be obtained.

For purposes of discussion we will say that the two groups, the interrelations of which we are attempting to determine, differ in two ways. First, they can be morphologically similar or different, and, second, they can be sympatric or allopatric. This gives four categories: morphologically similar and sympatric, morphologically different and sym-

patric, morphologically similar and allopatric, and morphologically different and allopatric. Such a classification was suggested by Mayr (1948; see also Moore, 1959). The various possibilities of population interrelations that are realized in these four categories are here considered.

1. Morphologically similar and sympatric. If two frogs are similar and sympatric, the initial supposition is that they belong to the same species. In the vast majority of situations such a verdict would be correct, but is not invariably so. There are now well-authenticated cases in frogs of two groups of individuals that are morphologically similar and sympatric yet maintain their specific distinctness. These are sibling species. Examples are known in *Crinia* (Main, 1957a; Littlejohn, 1957, 1958) and *Hyla* (Johnson, 1959). Situations of this sort cannot be discovered readily, unless some difference in behavior suggests that the morphologically similar individuals are not part of the same biological species. In frogs, the clue has always been differences in the breeding calls of the males. Once the groups have been defined on the basis of their calls, however, it is often possible to find other differences as well. Thus the two groups may differ in breeding season or breeding habitat. In addition, minute morphological differences, previously thought to be merely intraspecific variations, may characterize the two sibling species. The most critical evidence of their specific distinctness is obtained when crosses are made between the two forms and the offspring prove to be abnormal.

2. Morphologically different and sympatric. The initial supposition in this case is that there are two species. If field observations indicate that interbreeding between the two groups does not occur, this supposition is almost certainly correct. Data obtained from laboratory hybridizations must be interpreted with caution. They are conclusive only if they show that normal offspring cannot be obtained. Then one can be sure that two species are present. If seemingly normal offspring are produced, one cannot conclude that the two groups are conspecific, for there are numerous cases in which normal hybrids are obtained from laboratory crosses of "good" species, that is, ones that rarely or

never interbreed under natural conditions. An example from Australia is *Limnodynastes peroni* and *Limnodynastes tasmaniensis*. These do not interbreed in nature, but laboratory hybridizations result in the production of normal embryos.

A major exception to the rule that two morphologically different sympatric groups are different species is observed in species with clear-cut polymorphs. In *Crinia signifera* of eastern New South Wales there are at least three well-marked color types. These are easier to distinguish from one another than many pairs of species, such as *Limnodynastes tasmaniensis* and *Limnodynastes fletcheri*. At various times in the past the different types have been described as new species. In this situation it is essential to have data on the behavior of the groups under natural conditions. In the case of the color types of *Crinia signifera*, the different polymorphs cross with one another in nature, the males have the same calls (at least to my ear), and the habitats and breeding habits are the same. In spite of the conspicuous differences in color pattern, the various polymorphs are members of the same biological species. In the laboratory the different polymorphs can be crossed and the offspring are normal. (As stated above, this fact is not of critical importance; the data of hybridization experiments are critical only if it is found that normal hybrids cannot be produced.)

3. Morphologically similar and allopatric. The initial hypothesis for this case should be that the two groups are conspecific. The first indication that this hypothesis is not always correct came from a study of *Crinia "signifera"* from eastern New South Wales and Western Australia (Moore, 1954a; Main, 1957a). On the basis of morphological criteria, the eastern and western populations were previously thought to be conspecific. When individuals of the two populations are crossed, however, the hybrids are abnormal. The normal exchange of genetic materials seems impossible, so we must regard the two groups as different species. They are, in fact, allopatric sibling species.

There is still another conceivable situation. It is theoretically possible that two morphologically similar allopatric groups could produce normal hybrids when artificially crossed

and still be distinct species. I know of no examples, and indeed it would require very special sorts of evidence to establish a convincing case. Nevertheless, a little reflection on the sorts of interrelations that can obtain between populations suggests that eventually examples of this sort will be found.

4. Morphologically different and allopatric. When one is dealing with allopatric populations, the problem of identifying species may be difficult or even impossible. If two different, though presumably related, allopatric populations are encountered, should they be considered as different species, different subspecies, or the same species? When one has an abundance of specimens from the entire range of distribution, and these show a gradual cline of variation, the proper thing to do is to regard them as belonging to the same species. If there is a sharp break in the pattern of variation, but the differences are slight, perhaps the populations should be designated as subspecies. If, on the other hand, the differences are great, and especially if there are places where the two populations overlap without appreciable intergrading, the populations should be regarded as different species.

It has been possible to apply these rules to only a few Australian frogs. In most cases the collections are inadequate, and the localities from which specimens are available are so scattered that one has a problem similar to that of dealing with island populations. For example, consider the case of the *Crinia signifera*-like frogs from the Mt. Kosciusko area which are somewhat different from members of this species found near Sydney. H. W. Parker (1940) judged them to be subspecifically distinct and named them *Crinia signifera montana*. Could it be that they are different species? The material, however, is insufficient to establish whether or not there is complete intergradation between the Sydney and Kosciusko populations, and the Kosciusko frogs might as well be inhabitants of a remote island. When individuals from the two localities are crossed, however, the offspring develop in a perfectly normal manner (Moore, 1954a). On the basis of this observation, plus the fact that the morphological differences are trivial, there is no reason to regard them as other than a single species.

Yet again, there are true island populations of *Crinia signifera*-like frogs, in addition to these pseudo-island populations, that are the result of inadequate collecting. For example, according to H. W. Parker (1940) the individuals on the island of Tasmania differ somewhat from those on the mainland. He named them *Crinia signifera englishi*. When populations are restricted to different land masses that are well separated by an ocean barrier, intergradation is impossible. Nor is it possible to obtain the critical evidence of how the two groups would interact in areas of overlap. In situations of this sort cross-fertilization experiments have considerable utility. When one crosses individuals from Sydney and Tasmania, the offspring develop normally. On the basis of the close morphological similarity of the two populations and their ability to cross successfully, there is no reason to think that more than one species is involved.

A note of caution should be entered at this point. The reader may have been given the impression by this discussion that the taxonomy of two closely related allopatric populations is subject to exact treatment. Perhaps it was implied that, if two allopatric populations can be crossed and produce normal offspring, they are the same species and, if they do not, they are different species. Such, most certainly, is not my belief. Let us consider the case of a widely distributed species with gradual clinal variation and every evidence of free interchange of genes between adjacent populations. This would be an example of a biological species in the true sense of this category. But all the individuals of such a species are not genetically similar. Cases are known in frogs (*Rana pipiens*; Moore, 1946) in which individuals from widely separated parts of the species' range cannot be crossed successfully, yet there is no evidence of any incompatibility between adjacent populations. It seems probable that *Crinia signifera* has an unbroken distribution from Sydney to Darwin, with free interbreeding between adjacent populations. I would, however, not be surprised if a cross of individuals from these two widely separate localities would give a degree of hybrid defectiveness equal to that generally observed in interspecific crosses. Even if such were the case, I would regard them as members of the

same species. In all cases in which there is evidence for complete intergradation, I would adopt this view.

It may seem illogical that hybrid defectiveness is regarded as sufficient evidence for there being two species in the case of geographically isolated populations (New South Wales and Western Australian populations of *Crinia signifera*-like frogs, with their distribution sundered by the Nullarbor Plain), whereas the same degree of hybrid defectiveness is ignored if there is a continuous intergrading population, as in *Rana pipiens*. To me this dilemma merely reflects the fact that our existing system of classification does not and cannot express all types of inter-population relationships. Gene flow is possible if the populations are continuous, impossible if they are disjunct.

Nor must it be assumed that, if two morphologically different allopatric populations can be crossed successfully in the laboratory, they must be regarded as the same species. For this situation I can give only a hypothetical example. Let us suppose that *Limnodynastes tasmaniensis* and *Limnodynastes peroni*, as a result of some event in the past, have disjunct distributions instead of overlapping extensively as they actually do. We can pretend that *Limnodynastes tasmaniensis* is now restricted to Tasmania and *Limnodynastes peroni* to the mainland. In other respects we shall leave the biology of these species intact.

Let us now imagine that a zealous lumpner decides they are merely subspecies. In our hypothetical distribution there is no zone of overlap and, therefore, no opportunity for one to make the critical observations on the interrelations of the two forms where they are sympatric. Our zealous lumpner will offer to prove his point by performing cross fertilization experiments and, finding that the two forms can be crossed and the offspring are normal, is satisfied that they are subspecies.

In this case, however, I would not concur and regard the two as conspecific merely on the basis of their ability to cross. They differ so much in habitat, habits, voice, and appearance that it would seem more appropriate to call them different species. Of course this case is hypothetical, but there must be instances of this sort in nature. (There are numerous ex-

amples in other groups of organisms, especially in plants.)

Enough data are already available to show that it is difficult, if not impossible, to devise a consistent scheme for the classification of allopatric populations of frogs. A summary of the different situations and of the possible taxonomic solutions follows.

1. On the basis of morphological characteristics, two populations may be somewhat different in appearance and be regarded as conspecific (*Crinia signifera* from New South Wales and Tasmania); or they may be the same in appearance and not be regarded as conspecific (the *Crinia signifera*-like frogs from New South Wales and Western Australia).

2. On the basis of crossability, two populations may be able to cross successfully and be different species (the hypothetical situation devised for *Limnodynastes tasmaniensis* and *Limnodynastes peroni*); or they may not be able to cross successfully, yet be regarded as a single species (the *Rana pipiens* example).

3. On the basis of the behavior of its peripheral populations, a single species may consist of a continuously distributed group of allopatric populations, with the peripheral individuals able to cross and give normal offspring (*Rana catesbeiana* and probably the majority of American ranas); or the peripheral populations may not be able to produce normal offspring when crossed (*Rana pipiens*).

4. On the basis of complete geographic isolation, two allopatric populations may be conspecific (*Crinia signifera* in New South Wales and Tasmania) or be different species (the *Crinia signifera*-like frogs of New South Wales and Western Australia).

5. On the basis of the ability to cross in relation to the distance between the allopatric populations of a single species, individuals from localities 3500 miles apart may produce normal offspring (*Rana pipiens* from Vermont and Costa Rica) and others from localities only 1400 miles apart may produce abnormal offspring (*Rana pipiens* from Vermont and Florida).

Clearly, there are no sure rules, of universal application, for the classification of allopatric populations. The arbitrary rules that I use are these: If the distribution is continuous and

adjacent populations intergrade, I assume that a single species is involved. If the distribution is disjunct, or if material from intermediate localities is unavailable, and there are no data on the results of cross fertilization experiments, I guess as to the taxonomic status of the two forms. When guessing, I am a moderate lumpers. (I probably err in some cases, such as in regarding *Limnodynastes dorsalis* as being a single species, for it may turn out to be several species.)

A few remarks are here made concerning some of the other systematic categories. I have not thought it worth while to attempt a delimitation of subspecies for two reasons. First, the material available is not extensive enough for the task to be done satisfactorily. The second, and probably the more important reason, rests on my belief that the description of subspecies in frogs is of limited value. Nearly every species that I have studied shows geographic variation. The

differences may be marked or subtle, but, nevertheless, they are there. The number of subspecies that can be recognized depends to a considerable extent on how thorough a study one wishes to make. Even when one restricts oneself to the usual external characteristics, it is a rule that considerable geographic variation is found. When other, and possibly more important, characteristics are studied, it is found that they vary as well. Finally, when one knows enough about the biology of the species to attempt a delimitation of subspecies, he finds that the system of classification is not elegant enough to describe the variations adequately.

No attempt has been made to revise the genera of Australian frogs or even those occurring in eastern New South Wales. Work of this sort would require, especially in the Leptodactylidae, a careful study of the internal anatomy of many Australian and foreign species, and this has not been done.

ACKNOWLEDGMENTS

Many individuals and organizations have helped me in one way or another with this report. It is a pleasure to acknowledge this assistance, and in so doing memories of many happy associations are evoked.

Professor P. D. F. Murray allowed me to use the facilities of his department at Sydney University and took me on several field trips. Mr. J. R. Kinghorn aided my first steps in Australian herpetology and allowed me to use the collections of the Australian Museum. Dr. Allen Keast has assisted my work since its beginnings. We went on many collecting trips together. He has answered numerous queries about specimens in the Australian Museum and has offered much advice about general problems.

Dr. Donald McMichael, Dr. L. C. Birch, Dr. A. Stock, Dr. T. O'Farrell, Dr. J. Munro, Dr. Barbara Main, Dr. H. Waring, Dr. Betty Moore, Mr. A. Colefax, Mr. Harold Cogger, Mr. Peter Johnson, Mr. S. J. Copland, Mr. L. Condon, Mr. K. Meyers, Mr. William Hosmer, Miss Isobel Bennett, Miss Mary Besly, Mrs. Penney, Miss Sally Moore, and Mr. Nicholas White helped in one way or another with specimens.

Dr. A. R. Main introduced me to the West-

ern Australian species, and I have turned to him for advice on many matters.

Nearly all the work of preparing this report has been done at the American Museum of Natural History. I am grateful to Mr. C. M. Bogert for putting its facilities at my disposal. Both he and Dr. R. G. Zweifel have helped me constantly.

A Fulbright Grant made it possible for me to spend a year in Australia to study the frogs in their natural environments and the specimens in the Australian Museum. Barnard College, through its Faculty Research Fund, made it possible for me to study the important specimens of Australian frogs in the British Museum (Natural History) and the Muséum National d'Histoire Naturelle in Paris. Dr. Alice Grandison and Mr. J. Battersby helped me greatly at the first institution and Dr. J. Guibé at the second. Dr. Ernest Williams allowed me to use the specimens in the collection of the Museum of Comparative Zoölogy.

Finally, the writing of this report was completed during my tenure of a Guggenheim Fellowship and with the assistance of grant G9001 from the National Science Foundation.

THE FAMILY LEPTODACTYLIDAE

Mixophyes fasciolatus Günther

THE GREAT BARRED FROG

Plate 33, figure 1; text figures 1, 2

DIAGNOSIS

The broad head, the large adult size, the irregular and elongate dark patch on the back, and especially the cross bars on the arms and legs distinguish this species from all other frogs in eastern New South Wales. The dorsal pattern and cross barring of the appendages appear at metamorphosis, enabling one to identify both juveniles and adults.

Some individuals of *Lechriodus fletcheri* have similar bars on the appendages. The adults of the two species can be distinguished by the following features: *Lechriodus fletcheri* is a smaller species (maximum body length 50 mm., compared to 101 mm. for *Mixophyes fasciolatus*) and has a rudimentary web between the toes, ridges that extend along the sides from the snout to the middle of the body, and vomerine teeth behind the choanae. Small individuals of *Mixophyes fasciolatus* can be differentiated from *Lechriodus fletcheri* of the same size by the well-developed web between the toes, the absence of the lateral ridges, and vomerine teeth between the choanae.

DESCRIPTION

Mixophyes fasciolatus is one of the largest as well as one of the most attractive of the Australian amphibians. In the most common color type, the background color of the dorsal side is pale brown. In the center of the back of most individuals there is an elongate and irregular patch, which begins at the level of the eyes and extends three-quarters of the way to the posterior end of the body. This patch is slightly darker than the background. It is about 1 cm. wide and frequently it has a crudely hourglass shape. In addition to this median patch, there are some smaller dark blotches scattered irregularly over the back and on the sides at the junction of the pigmented dorsal and pale ventral surfaces. In some individuals the dorsal patch is smaller or even reduced to irregular spots.

On each side there is a black band that extends from the snout to the eye, and from the eye across the tympanic membrane. It terminates posteriorly about 2 to 5 mm. behind the tympanic membrane. There are usually brown blotches on the upper jaw.

The dorsal sides of the arms and legs are pale brown, with narrow black cross bars. The cross bars on the arm widen posteriorly, and on the legs they widen both anteriorly and posteriorly. In some individuals the bands on the posterior surface of the thighs have become so wide that this area is black with only a few irregular white spots.

The ventral surface is white, except for a dark grayish wash along the lower jaw and occasional mottling on the throat, which is usually more prominent in males than in females.

In general shape, *Mixophyes fasciolatus* is broad of head and body. The largest specimen that I have seen is a female 101 mm. in length from Dunoon on the Richmond River, New South Wales (Australian Museum No. 7493). Most adults fall in the 50- to 80-mm. range. The head is wide and long, the head width/head length ratio averaging 1.07 ± 0.05 (1.02-1.17) and the head length/body length ratio averaging 0.42 ± 0.02 (0.38-0.44). The legs are of moderate length, the tibia length/body length ratio averaging 0.64 ± 0.05 , (0.54-0.68). These data are for the nine specimens in the American Museum of Natural History, which vary from 58.0 to 90.6 mm. in body length.

The tympanic membrane is distinct and oval. Its axis is dorsoventral or tipped slightly towards the eye.

The fingers are not webbed (fig. 1). When they are arranged according to length, the sequence is $3 > 1 \geq 2 = 4$. The inner metacarpal tubercle is elongate and well developed; the outer metacarpal tubercle is oval and moderately well developed.

The toes are webbed, the amount of webbing varying. In most specimens the fourth toe has three joints free, but in others only two joints are free. The greatest amount of webbing that I have seen is in some specimens from northeast New South Wales. The inner

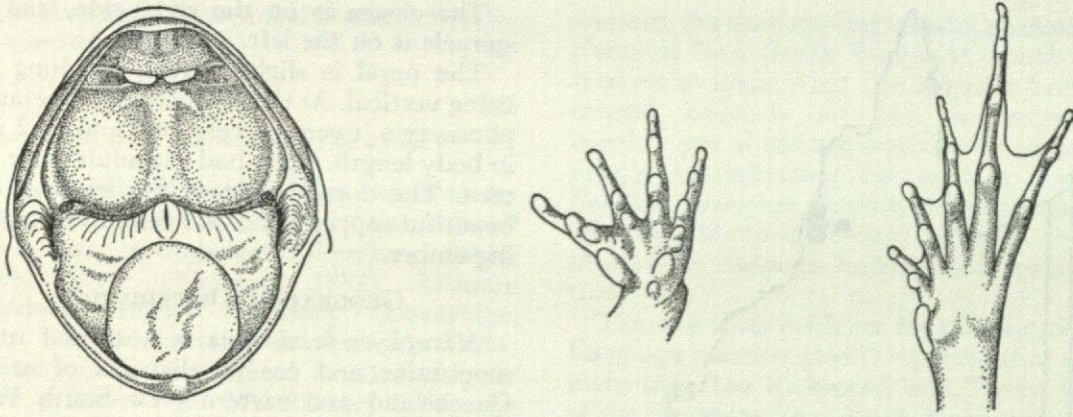


FIG. 1. *Mixophyes fasciolatus*. Open mouth, hand, and foot.
A.M.N.H. No. 13326. Byron Bay, New South Wales.

metatarsal tubercle is elongate and moderately well developed. There is no outer metatarsal tubercle. The soles of the feet are black.

The tongue is broad and generally has a slight notch at the posterior end (fig. 1). The vomerine teeth are between the internal openings of the nostrils. In some individuals those of the two sides meet, but in most there is a slight separation.

HABITAT

I have found adults of this species on the floor of the rain forest at Binna Burra, Queensland, and along the sandy banks of the Grose River at Blackheath in the Blue Mountains of New South Wales. In both localities the individuals were taken at night.

Fletcher (1889) describes it as a "diurnal frog haunting the banks and creeks in deep shady gullies." The same author (1892) lists it as one of "the species frequenting the semi-tropical brushes of our northern river districts, or the sequestered gullies of the Blue Mts., or the Illawarra Range." Harrison (1922) collected metamorphosing individuals in a small creek running through a grass paddock.

I have collected large tadpoles in the Coomera River, a swift-flowing mountain stream near Binna Burra, Queensland (pl. 27, fig. 1), at an elevation of 2400 feet. Others were taken in a small mountain brook near the top of Point Lookout near Ebor, New South Wales, at an altitude of 5000 feet. Available data seem to indicate that this species occupies a variety of habitats from

lowland coastal rivers to the highest mountain brooks found within its range.

BREEDING HABITS

I have not observed the breeding of this species and cannot find any accounts in the literature. Fletcher (1889) mentions that clasping is axillary.

EMBRYONIC DEVELOPMENT

Nothing is known of the early development. Tadpoles are of considerable interest in being of the "mountain-brook" type. They show the chief features correlated with life in fast-running waters, such as small tail fins, a streamlined body, a wide muscular portion of the tail, and a suctorial mouth.

The tadpoles are approximately 65 mm. in total length immediately before metamorphosis. The coloration of the dorsal side is a rich dark brown, almost sepia. There are numerous golden pigment cells, which vary from small dots to near invisibility, the state of expansion probably being due to light conditions. In some tadpoles there is a suggestion of indistinct black spots on the dorsal side. The lateral lines are prominent. The ventral side is grayish, with numerous golden pigment cells. In some animals the muscular portion of the tail, the dorsal fin, and the posterior third of the ventral fin have small clusters of melanophores. These give the tail a mottled appearance. In others the tail is uniformly dark.

The hind legs are covered by a membrane, which remains over them until the last stages

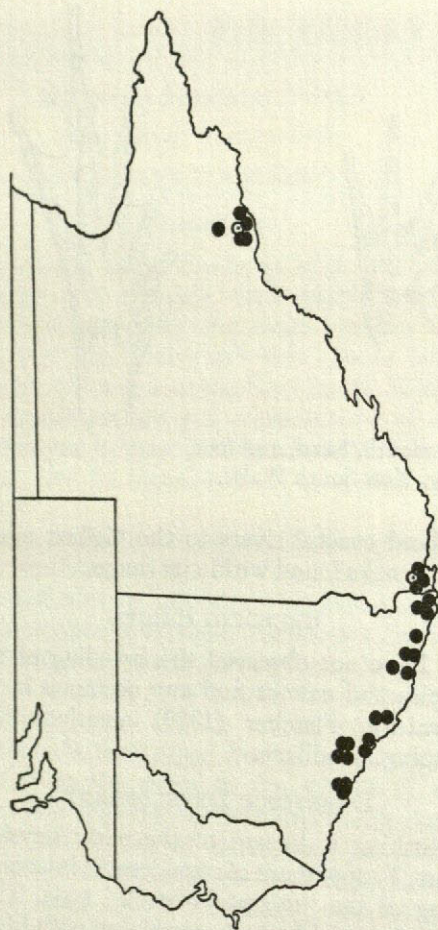


FIG. 2. *Mixophyes fasciolatus*. Geographic distribution.

of metamorphosis. *Mixophyes fasciolatus* is the only Australian species in which this peculiar feature was noticed.

The mouth region of the tadpole is characterized by numerous rows of teeth, usually nine. The upper lip has a single row of papillae extending from one side to the other. The lower lip has two rows of papillae, with a space between. In the field, the tadpoles were seen to attach themselves to rocks in rapidly flowing water. The ability of the mouth to serve as a suction organ was noticed in laboratory specimens as well. When the water was emptied from the jars in which tadpoles were being kept, it was usual for many of them to remain attached by their mouths to the sides of the emptied container. A fairly vigorous shake was necessary to detach them.

The cloaca is on the right side, and the spiracle is on the left.

The pupil is slightly oval, the long axis being vertical. At the completion of metamorphosis two juveniles were 20.0 and 21.2 mm. in body length. They had the adult color pattern. The dorsal third of the iris was of a beautiful copper color that resembled a glowing ember.

GEOGRAPHIC DISTRIBUTION

Mixophyes fasciolatus is restricted to the mountains and coastal districts of eastern Queensland and eastern New South Wales (fig. 2). It is found in the coastal rivers of New South Wales and at an elevation of 5000 feet (Point Lookout, near Ebor, New South Wales). The northern and southern limits are Speewah (just west of Cairns), Queensland, and Kiama, New South Wales. The type locality is the Clarence River, New South Wales.

This species avoids the Sydney area but is known from nearby localities such as Gosford, the Blue Mountains, and the Illawarra district.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Mullumbimby (No. 12308)
- Richmond River (No. 5090)
- Dunoon, Richmond River (Nos. 7493, 7494)
- Clarence River (No. 6791)
- Lowana, Dorrig (Nos. 7550, 12642-12656)
- Dorrig Scrub (No. 10456)
- Warrell Creek, Nambucca River (No. 4247)
- Gurravambi, Nambucca River (Nos. 6285, 6287, 6289, 6291)
- Nambucca River (Nos. 5872-5874, 5876, 5877, 9463, 13543)
- Williams River (Nos. 9217, 9218, 9220, 9226)
- Blue Gum Knob, Upper Chichester (Nos. 7622, 7623)
- Wyong (No. 10506)
- Palmdale, Wyong (No. 12081)
- Avoca, near Gosford (Nos. 8472, 6499)
- Kurrajong Heights (No. 7479)
- Mt. Irvine (Nos. 12788, 12789)
- Blackheath (No. 10063)
- Mt. Wilson (Nos. 8237-8329, 12567)
- Moss Vale district (No. 8455)
- Burrawang (No. 7587)
- Illawarra (No. 7567)
- Kiama (No. 6792)

The American Museum of Natural History has specimens from:

Byron Bay (No. 13326)

Ourimbah (No. 13327)

Grose River, near Blackheath (No. 58862)

New South Wales localities reported by other authors, in addition to those listed above, are Springwood (Fletcher, 1889), Tweed River (Fletcher, 1892), Lismore (Harrison, 1922), Salisbury (Loveridge, 1935), Pine Mountains* (Keferstein, 1868a; this may be a Queensland locality), Upper Maring River* (H. W. Parker, 1940; the "Maring" River may be the Manning River), Cox River in the Blue Mountains and Ulong (Slevin, 1955).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Millaa Millaa, Atherton Tableland (No. 10909)

Cairns district (Nos. 770, 4693)

Almaden (No. 9284)

Pine Mountain (No. 6794)

Mt. Tambourine (Nos. 8937, 8939)

MacPherson Range (No. 9369)

The American Museum of Natural History has specimens from:

Speewah (No. 54183)

Ravenshoe (Nos. 19941, 19942, 19944, 19945)

Binna Burra, Beechmont (No. 58863)

Queensland localities reported by other authors, in addition to those listed above, are Lake Barrine in the Atherton Tableland, Bellenden Ker Range, Bunya Mountains (Loveridge, 1935), and Malanda (Andersson, 1916).

COMMENTS

One problem concerning *Mixophyes fasciolatus* is very interesting, but I have not the material necessary to provide the answer. There is some evidence suggesting that two species or subspecies may be involved. As noted above, the tadpole of this species is of the "mountain-brook" type. At least this is true for Point Lookout (Ebor, New South Wales) and Binna Burra (Beechmont, Queensland) where tadpoles were taken in swift-flowing streams. *Mixophyes fasciolatus* occupies quite a different sort of habitat as well,

namely, the slow-moving coastal streams and rivers of New South Wales. It would be of interest to know what the tadpoles from the coastal lowlands are like. A "mountain-brook" type of tadpole would seem an unnecessary specialization for such a habitat. Perhaps there are actually two species, one with the "mountain-brook" tadpoles and another with tadpoles lacking this specialization.

There is other evidence for this suggestion. Long ago Fletcher (1892) reported that specimens from the Richmond and Tweed rivers of northeastern New South Wales differed in leg length and webbing from the types, as well as from specimens collected in the Blue Mountains. Slevin (1955) noted unusually full webs on two of three Ulong specimens. Specimens in the Australian Museum from Lowana, Mullumbimby, and Dunoon, New South Wales, have more extensive webbing than specimens from other areas, and they differ in pigmentation as well. A specimen (A.M.N.H. No. 58862) from the Grose River Valley in the Blue Mountains has a similar well-developed web. It differs from upland specimens in other characters also. Field work in the New England highlands, the McPherson Range, and the adjacent coastal lowlands should settle the question as to whether there is one species or two.

It will be noticed from figure 2 that there is a gap in the known distribution of *Mixophyes fasciolatus*, but so little collecting has been done along the coast of central Queensland that this gap cannot be taken as well established. Loveridge (1933a) recognized the north Queensland population as a distinct subspecies, *Mixophyes fasciolatus schevilli*, but mentioned that there was some doubt of its validity, owing to an insufficiency of material at his disposal. Andersson (1916) remarked on the north Queensland individuals. H. W. Parker (1940) followed Loveridge in recognizing a northern subspecies, but he did not have specimens from north Queensland for study.

Mixophyes fasciolatus schevilli was differentiated from the southern populations because of the possession of more extensive webbing. After examining the extensive series in the Australian Museum, which includes a paratype of *schevilli*, I do not believe it neces-

sary to recognize this northern subspecies on the basis of the characters given by Loveridge. Many specimens from northeastern New South Wales have even more extensive webs than *schevilli*, and, furthermore, the difference is so trivial that little would be gained by emphasizing it. Slevin (1955) mentioned the fact that some of his New South Wales specimens had webs as extensive as those thought diagnostic for *schevilli*.

If there is a large gap in the distribution of *Mixophyes fasciolatus*, it may well be that the northern and southern populations have diverged, but there is not sufficient evidence at this time to indicate that they have.

LITERATURE

The original description, which includes a good figure, of the genus *Mixophyes* and the species *fasciolatus* is to be found in Günther (1864a, 1864b). The cotypes, which are from the Clarence River of New South Wales, are in the British Museum (Natural History). Other descriptions, which include geographical records, are given by Steindachner ("1869" [1870]), Keferstein (1868a, with a figure of the pectoral girdle), Boulenger (1882), de Vis (1884b, as *Hyla fenestrata*), Fletcher (1892), Lucas and Le Souëf (1909, with a photograph of a preserved specimen), Andersson (1916), Nieden (1923), Loveridge (1935), H. W. Parker (1940, with a figure of the palate), and Slevin (1955).

In addition, geographical records are given in Krefft (1865, as *Myxophyes fasciolatus*), Krefft (1867), Krefft (1870, as *Myxophies fasciolatus*), Günther (1868a), Fletcher (1889, 1890, and 1894b).

Notes on the habits of this species can be found in Krefft (1865), Fletcher (1889), Lucas and Le Souëf (1909), and Harrison (1922).

Trewavas (1933) has described the hyoid and larynx of a juvenile specimen. Kesteven (1944) discusses some aspects of the morphology of the tadpole and adult.

The form described as *Hyla fenestrata* by de Vis (1884b) from the Tweed River is a synonym of *Mixophyes fasciolatus* according to Boulenger (1885). This is the only major synonym.

Loveridge (1933a) described the subspecies *Mixophyes fasciolatus schevilli* from Milla Milla, Queensland. The holotype and two

paratypes are in the Museum of Comparative Zoölogy.

The species is mentioned by Aflalo (1896), Johnston (1912), Fry (1912), and Barrett (1943).

***Cyclorana alboguttatus* (Günther)**

THE STRIPED BURROWING FROG

Plate 34, figure 1; text figures 3, 4

DIAGNOSIS

Cyclorana alboguttatus can be distinguished from other eastern New South Wales frogs by a combination of these characters: the thumb is longer than the second finger and opposable, the body is moderately stout, there are no pads (as are present in *Hyla*) on the fingers or toes, the inner metatarsal tubercle is equal to the length of first toe, and usually there is a light median dorsal stripe.

In general body form and in the coloration of preserved specimens, *Cyclorana alboguttatus* has a superficial resemblance to *Hyla aurea raniformis*. Both have a light dorsal stripe, dorsolateral folds, frequently round white spots on the posterior surface of the thigh, and a granular belly. The two can be readily distinguished, because *Cyclorana alboguttatus* lacks finger and toe pads and has the first finger longer than the second. *Hyla aurea raniformis* has small pads on the fingers and toes, and the second finger is longer than the first. As a further check, the inner metatarsal tubercle should be examined. In *Cyclorana alboguttatus* it is as long as the first toe, whereas in *Hyla aurea raniformis* it is much shorter.

DESCRIPTION

The following description is based on individuals from Rainsby Station, near Aramac, Queensland. I did not encounter this species in New South Wales.

The general coloration of the dorsal surface is olive-gray. There is a very pale narrow stripe that extends along the dorsal midline from near the snout to the cloaca. There are irregular dark spots on the back that tend to be arranged in four to six vaguely defined longitudinal rows. There is a brown stripe on each side extending from the snout through the nostril to the eye and from the eye through the tympanic membrane and along the side of the body.

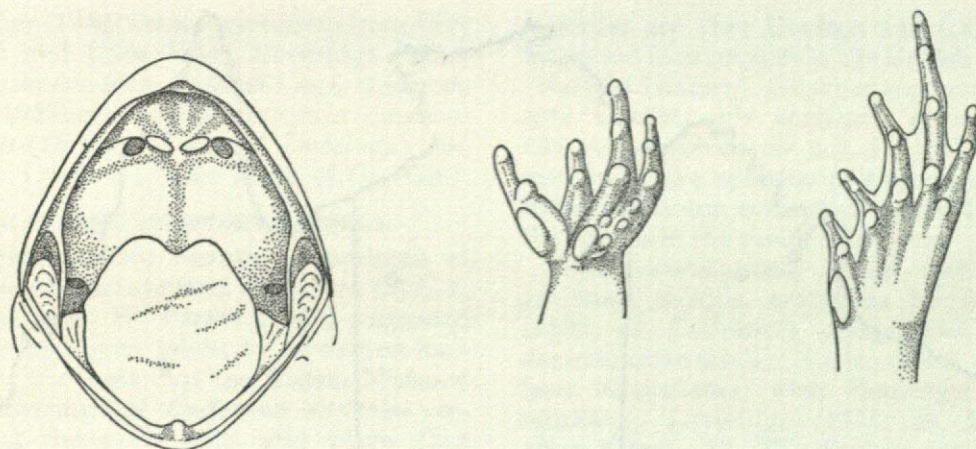


FIG. 3. *Cyclorana alboguttatus*. Open mouth, hand, and foot. A.M.N.H. No. 58903. Rainsby Station, near Aramac, Queensland.

The dorsal surface of the arms and legs is olive-gray, with irregular and indistinct dark blotches. The posterior surface of the thighs has numerous small, pale, yellowish green spots, which are ringed with black. The anterior surface of the thighs is similar in most specimens, but in others the light areas are irregular.

The throat is white, with a brownish mottling that may be restricted to the sides or may reach the midline. The rest of the ventral surface is white. The iris is golden.

There is a fairly prominent dorsolateral fold on each side, and there may be one or two additional incomplete and rather indistinct rows of elongate warts. The posterior half of the ventral side is finely granular.

This is a moderately robust species. The largest individual I have seen is a female 64.3 mm. in body length. H. W. Parker (1940) records a female that is 65 mm. The legs are short, the mean tibia length/body length ratio being 0.49 ± 0.01 (0.48–0.52). The head proportions are not extreme. The head width/head length ratio is 1.00 ± 0.01 (0.98–1.02), and the head length/body length ratio is 0.41 ± 0.01 (0.39–0.42). These measurements are based on 11 specimens varying in body length from 47.2 to 64.3 mm. Nine of these are now in the collection of the American Museum of Natural History. All were collected at Rainsby Station, Aramac, Queensland.

The tympanic membrane is distinct.

The fingers (fig. 3) differ in length as follows: $3 > 4 = 1 > 2$. If they are examined with a hand lens, they will be seen to have flanges on each side. The inner metacarpal tubercle is elongate. The outer metacarpal is oval and may be almost divided in two.

The toes are moderately webbed, two joints of the fourth toe being free (fig. 3). There is a metatarsal tubercle on the inner but none on the outer side. It is elongate and well developed, as is usual with burrowing forms.

The tongue is a broad oval, and it has a slight nick on the posterior edge. The vomerine teeth are between the internal nostrils. They are in elongate series which are slightly separated in some individuals but which nearly meet in others.

HABITAT

This species has been recorded from a diversity of habitats varying from those with high rainfall (Mt. Wilson, New South Wales) to others in semi-arid regions (Rainsby Station, Aramac, Queensland). My only field experience with this species was at Rainsby Station, Aramac, Queensland, during the dry season. A few adults were calling at night. They were sitting on the moist earth under a water trough. Other individuals were obtained by digging in recently moistened earth in a garden. They were 6 to 10 inches below the surface. These individuals were well expanded, and a considerable amount of fluid

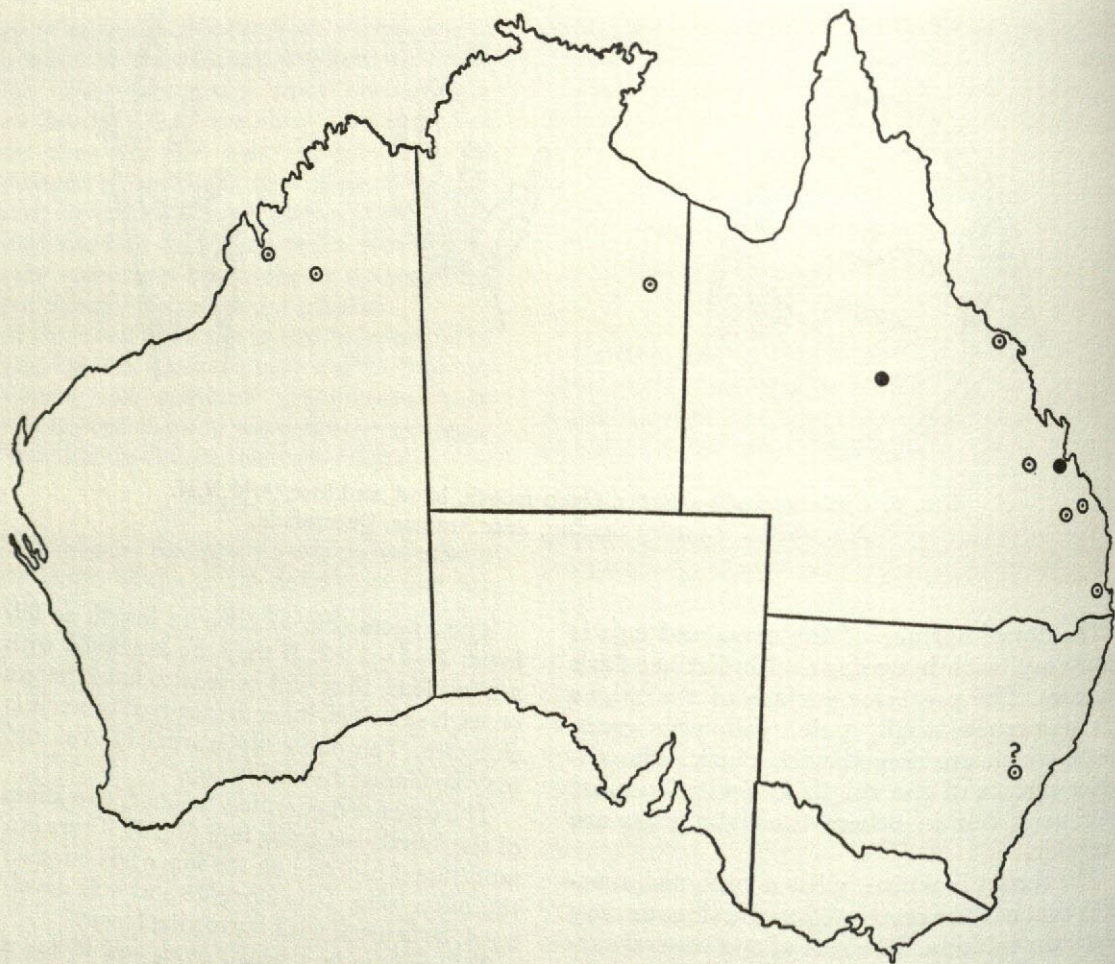


FIG. 4. *Cyclorana alboguttatus*. Geographic distribution.

could be expelled by gently squeezing the sides of the body. The fat bodies were huge.

VOICE

The call of males in the situation described in the last paragraph is a trill that carries for several hundred yards. It can be imitated if one places the tip of one's tongue in the middle of the hard palate and trills a "dk" for half a second.

EMBRYONIC DEVELOPMENT

It seems most probable, from an examination of the ovary of preserved specimens, that the mature eggs are about 1.5 mm. in diameter. Because the eggs are so small, their development probably includes a tadpole stage.

GEOGRAPHIC DISTRIBUTION

The range of this species is poorly known (fig. 4). In eastern Australia it extends from

Cape York, Queensland, to Mt. Wilson (?), New South Wales. The most western record is Alexandra, Northern Territory (or possibly Kings Sound, Western Australia). The co-types are from Port Denison (at Bowen, Queensland) and Cape York.

NEW SOUTH WALES RECORDS

Boulenger (1882) and H. W. Parker (1940) have a questionable record from the Clarence River. Loveridge (1935) lists a specimen from Mt. Wilson in the Blue Mountains (but see further under comments, below).

QUEENSLAND RECORDS

The American Museum of Natural History has specimens from:

Rainsby Station near Aramac, Queensland (Nos. 58894-58903)

Rockhampton (No. 23577)

Günther (1867), Boulenger (1882), and H.

W. Parker (1940) record specimens from Port Denison and Cape York. Loveridge (1935) lists specimens from Eidsvold and Brisbane. Slevin (1955) collected specimens at Coomoolaroo (15 miles north of Duaringa) and Kolonga Creek (25 miles north of Gin Gin).

NORTHERN TERRITORY RECORDS

Loveridge (1935) records a specimen of *Cyclorana alboguttatus* from Alexandra (M.C.Z. No. 11647). H. W. Parker (1940) suggested that this specimen might be *Cyclorana australis*, on the basis that the British Museum has a specimen of *Cyclorana australis* collected at the same time and place (but Parker calls it Alexandria), implying that *Cyclorana alboguttatus* and *Cyclorana australis* might not be expected to occur together. Loveridge (1949) has reaffirmed his identification. Because I have taken both species (pl. 33, fig. 2; pl. 34, fig. 1) at Rainsby Station, Aramac, Queensland, there is no doubt that the two species occur together (also see Mitchell, 1955).

WESTERN AUSTRALIA RECORDS

Fletcher (1898) reports that this species occurs at Kings Sound, Derby, and at the junction of the Fitzroy River and Margaret Creek. These Western Australia records are in need of confirmation. They are entered in figure 4 with considerable misgivings.

(I did not examine this or any other species of *Cyclorana* in the collection of the Australian Museum so am unable to give more complete data on distribution.)

COMMENTS

Cyclorana alboguttatus is included among the eastern New South Wales frogs mainly on the basis of Loveridge's (1935) mention of a specimen (M.C.Z. No. 18529) from Mt. Wilson. It seems improbable to me that this species occurs in the Mt. Wilson area. An attempt to check this doubt by examining the specimen has not been possible. Dr. Ernest Williams, the Curator of Amphibians at the Museum of Comparative Zoölogy, is unable to locate the specimen and further adds that the catalogue now lists No. 18529 as *Mixophyes fasciolatus*.

LITERATURE

This species was described as *Chiroleptes alboguttatus* by Günther (1867). The type

localities are Port Denison and Cape York. There are four cotypes in the British Museum (Natural History). Günther was not entirely sure whether his specimen differed from *Chiroleptes inermis* or not. In 1868 Günther mentioned the addition of a specimen to the British Museum collection. Cope (1889) put the species in the genus *Mitrolysis*.

Other descriptions, which include geographical records, are given by Boulenger (1882, as *Chiroleptes alboguttatus*, with a drawing of an adult); Nieden (1923, as *Mitrolysis alboguttatus*, with Boulenger's figure redrawn); Loveridge (1935, as *Mitrolysis alboguttatus*); H. W. Parker (1940), and Slevin (1955, with a photograph of a dead specimen, under the name *Cyclorana alboguttatus*).

Fletcher (1898, as *Chiroleptes alboguttatus*) gives records from Western Australia, and Boettger (1892, as *Chiroleptes alboguttatus*) a record from Queensland.

Sweet (1908, as *Chiroleptes alboguttatus*) has studied the nephrostomes and the connection between the vasa efferentia and the kidney. Dawson (1948, 1951) has studied the histology of the kidney.

The relation of this species to *Chiroleptes* (= *Cyclorana*) *inermis* is discussed by Steindachner (1868).

Lechriodus fletcheri (Boulenger)

FLETCHER'S FROG

Plate 34, figure 3; text figures 5, 6

DIAGNOSIS

The ridges of skin that extend along the sides from the snout to the middle of the body plus the rudimentary webbing of the toes distinguish this species from all others in eastern New South Wales. These characteristics permit identification of preserved specimens.

DESCRIPTION

In life this frog varies from a dark olive-brown to nearly black on the upper parts. A few black spots are usually present, a bar between the eyes being the most frequent. The most distinctive feature is a light-colored ridge of skin that extends from the snout through the eye, across the top of the tympanic membrane, and then along the side of the body to a termination immediately posterior to the level of the arms. There is always

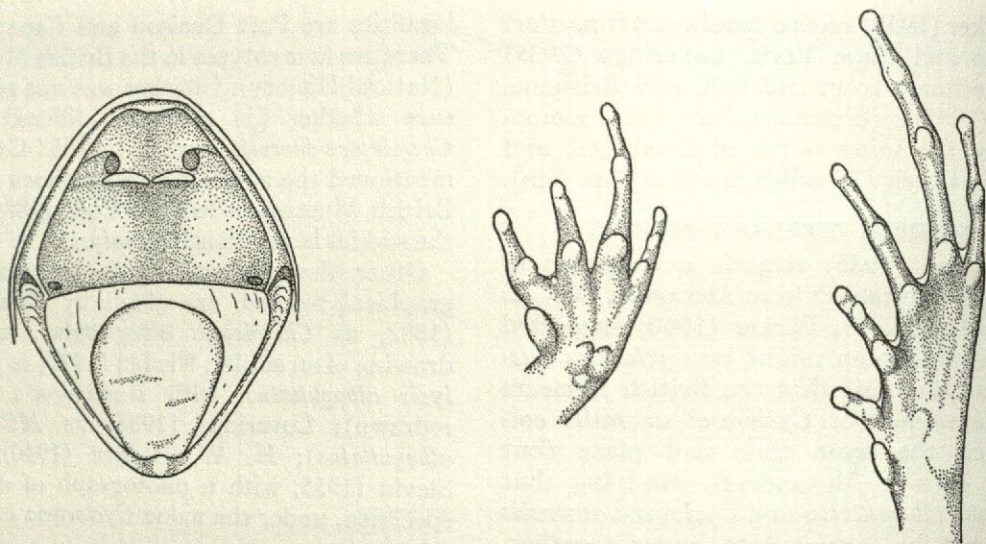


FIG. 5. *Lechriodus fletcheri*. Open mouth, hand, and foot. A.M.N.H. No. 58953. Binna Burra, Beechmont, Queensland.

a black stripe below that portion of the ridge posterior to the eyes and in some specimens in the more anterior region as well. In addition to the ridge already referred to, the dorsal surface is covered with small ridges and minute tubercles that tend to be arranged in rows parallel to the long axis of the body. These minute tubercles are present on the appendages as well.

The upper jaw is edged with small black markings, and, in addition, there is frequently a large dark patch below the eye. In some specimens the dorsal surfaces of the appendages are cross barred with narrow black bands, but in others these are lacking and the coloration is the same as the remainder of the upper surface.

The posterior surface of the thigh varies from dark olive-brown to nearly black. The ventral surface of the foot is black.

The under parts are white, and there is a faint speckling of olive-brown on the throat. The edge of the lower jaw is dark.

This is a frog of average body proportions. In the specimens that I have examined, the maximum body size for males is 46 mm. and for females 50 mm. The Australian Museum has a fine series from Lowanna, New South Wales (Nos. 12618-12634). Eleven of these are males with well-developed nuptial pads. The mean body length of these is 44.2 mm. (range, 42.2-46.3), and the mean tibia

length/body length ratio is 0.59 ± 0.01 (0.58-0.61). In eight females with spatulate fingers the mean body length is 46.8 mm. range, 45.0-49.5), and the mean tibia length/body length ratio is 0.58 ± 0.02 (0.56-0.62).

One female and two males in the American Museum of Natural History, from Ravenshoe and Binna Burra, Queensland, respectively, range in body length from 43.6 to 45.1 mm. Their mean tibia length/body length ratio is 0.59 (range, 0.59-0.60). The mean head width/head length ratio is 1.06 (range, 1.06-1.07) and the head length/body length ratio is 0.36 for all of the specimens.

The tympanic membrane is distinct and oval, the long axis being vertical.

The fingers have a rudimentary web (fig. 5); arranged according to length, the sequence is $3 > 2 > 1 \geq 4$.

There is a marked sexual dimorphism associated with the fingers. In the series of Australian Museum specimens collected at Lowanna, New South Wales, in January, 1943, the males have dark areas on the dorsal side of the first, second, and, in some cases, third fingers, and usually on the median side of the inner metacarpal tubercle. If these areas are examined at a magnification of $\times 6$ or greater, they are found to consist of many tiny spines. Similar spines also occur on the outer edge of the fifth toe and usually on the

small tubercles scattered over the dorsal surface. The spines on the hand probably aid the male in holding the female during spawning. The female lacks these spines but her first and second fingers are spatulate, which is a characteristic of those species producing foam nests. Noble (1931, p. 114) has figures of the hand of a male and a female *Lechriodus melanopyga*, a species that is very similar to *Lechriodus fletcheri*.

The toes have a rudimentary web, four joints of the fourth toe being free (fig. 5). There is an inner, but no outer, metatarsal tubercle. The males have well-developed lateral fringes on the toes. These are folded over the toes to form a loose sheath. The females have rudiments of these fringes.

The tongue is of medium width (fig. 5). The vomerine teeth are in two rows posterior to the choanae. The two rows meet at the midline and extend laterally to the outer edge of the choanae.

HABITAT

I have encountered this species in streams and pools in the rain forest near Binna Burra, Queensland (pl. 27, fig. 1). In this area it was found at 2100 and 3000 feet. Fletcher (1891a) refers to it as a "brush-haunting species." Fry (1915) records it from Ourimbah, New South Wales, and writes, "Ourimbah is about forty miles north of Sydney and is the southern termination of a stretch of 'Dorrigo Scrub' country possessing the same geological and botanical features as that in which the types were procured." (The types were from Dunoon, Richmond River, New South Wales.)

Slevin (1955) found *Lechriodus fletcheri* at Ulong, New South Wales, "... in the virgin rain forest where timber was being cut. Ruts formed by the heavy tires of the logging trucks along the roads and filled with water by the night rains were their favorite haunts. On the collecting date, February 15, these frogs were breeding and the puddles containing heavy patches of gelatinous froth containing quantities of small, black eggs."

VOICE

The call of the male is a single note that may be described as "g-a-r-r-up." Each note is deep, loud, and has a duration of about one

second. It is repeated at short intervals. This call was heard during the daytime while the male was in a pool with eggs that had recently been laid.

BREEDING HABITS

On December 19, 1952, two egg masses were found at 3000 feet on Bower Bird Creek, a small mountain stream near Binna Burra, Queensland. Each mass was in a separate pool, and the pools were about 1 meter in diameter and 15 cm. deep. Water was flowing slowly through the pools, which had a thick layer of dead leaves on the bottom. The water temperature was 16° C. The egg masses were of the foam type and were similar to those of *Limnodynastes peroni*, *Limnodynastes tasmaniensis*, and *Adelotus brevis*. Each mass was about 8 by 14 cm. in length and breadth and about 2 cm. in thickness. Identification was established by raising the embryos to metamorphosis. Tadpoles of *Lechriodus fletcheri* were found in the pool, and they seemed to be eating the eggs.

Tadpoles of this species were found at a second locality near Binna Burra, namely, in a small pool of standing water adjacent to the Coomera River (altitude 2400 feet; pl. 27, fig. 1). Once again the identification was made by raising the embryos to metamorphosis.

Slevin (1955) found embryos of this species on February 15 at Ulong, New South Wales.

EMBRYONIC DEVELOPMENT

These observations on the development of *Lechriodus fletcheri* were made on a single group of embryos collected at Binna Burra, Queensland, during the early afternoon of December 19, 1952. The embryos were early blastulae (stage 7), which means that they must have begun development early in the morning of the same day. They had a diameter of 1.7 mm. The animal hemisphere was black, and the vegetal hemisphere was nearly white.

There was nothing unusual about the early stages of development; they closely resembled those we think of as typical for frogs, such as *Rana sylvatica* (Pollister and Moore, 1937).

At 48 hours the embryos were early neurulae (stage 14), and elongation had begun, the length and width being 2.2 and 1.6 mm. By evening of this day the tail-bud stage was

reached (stage 17), and the embryos were 3.7 mm. in length. The pronephric swellings, olfactory organs, suckers, and external indications of myotomes had appeared. That the gill plate was unusually large was the first external difference from the usual *Rana* type noted in the development of *Lechriodus fletcheri*.

Stages 19 (heart beat) and 20 (gill circulation) are reached after three days of development. The stage-20 embryo is 6.0 mm. in length. Once again the external form is almost identical with that of *Rana* with the exception of gill structure. The gills begin as three parallel ridges on the gill plate. The long axes of these ridges are vertical. The anterior ridge is the largest and the posterior the smallest. The ridges, in a few hours after they appear, become divided into the gill filaments. The result is three vertical rows of overlapping filaments, each row consisting of from six to eight finger-like filaments.

The operculum begins to overgrow the gills when the embryos are four days old. The length at this time is 8.5 mm. The tail fin is transparent as is much of the body epidermis. The eyes, which are unusually small, have black pigment, and the loops of the gut can be distinguished.

The five-day embryos are 11.2 mm. in length. The operculum has overgrown the gills completely, and the spiracle is on the left side. The suckers have begun to disappear, and the horny teeth and oral papillae make their appearance. The hind-limb buds are prominent, an unusual feature reminding one of the early appearance of these structures in *Pseudophryne australis*. Melanophores have also appeared.

The temperatures at which these embryos developed during the first five days fluctuated between 11° C. and 24° C., and the average was about 18° C. Accurate comparisons are not possible with such crude temperature data, but I believe that *Lechriodus fletcheri* develops more rapidly than any other species, Australian or American, that I have ever studied.

The seven-day embryos are 13.0 mm. in length. Horny jaws and teeth are present, and the suckers have almost disappeared. The anus is open. Melanophores are spread over the dorsal surface of the body and the

myotome area of the proximal half of the tail. There are no golden pigment cells at this stage.

By 26 days the tadpoles reach a length of 33 mm., the maximum size. Both the dorsal and ventral surfaces have numerous melanophores and also numerous golden chromatophores. The tail, except for the ventral fin, is heavily pigmented. The intestine appears as a series of parallel folds extending across the body. The anus is very large and opens on the right side of the ventral fin. The junction of the body and the tail forms a right angle, when viewed from above, which gives the body a "chopped-off" appearance. The eyes are small and close together. The mouth is almost terminal in position. It is fringed by a nearly complete single row of oral papillae, these being absent only from the middle portion of the upper lip. There are two rows of teeth above the upper jaw (the second being broken in the center), three (rarely, four) short rows on each side of the jaws, and three rows below the lower jaw. The row immediately below the lower jaw is interrupted in the center. The hind legs are pigmented and completely formed. The arms are also fully formed at this time and can be seen through the skin.

After 31 days of development, the arms on some of the tadpoles emerged. The tail was resorbed in a few days, and the juvenile stage began. The characteristic ridges and warts of the adult appear at this time, so identification can be made at this early stage. The body length of the newly transformed young is 10.0 to 10.5 mm.

The tadpoles of *Lechriodus fletcheri* can be distinguished from those of the other Australian species with which I am familiar by a combination of these characteristics: anus on right; terminal mouth; cross folding of the intestine; and the fact that the posterior part of the body forms a right angle with the tail.

The tadpoles of this species were the most voracious of the many forms that I have raised. They were cannibalistic, and, unless an excess of food was kept in their aquaria, the smallest individuals were killed and eaten. On several occasions they were given injured tadpoles. When these were dropped into the aquaria the *Lechriodus* tadpoles became frenzied and literally tore the injured

tadpole apart in a few minutes. It would be of interest to know if tadpoles of other species can survive in pools containing *Lechriodus* and to what extent *Lechriodus* depends on cannibalism for nutrition in the tadpole stage. In this connection it might be mentioned that the pools in which the eggs of *Lechriodus* were collected contained many tadpoles, and these were busily feeding on the newly laid eggs.

GEOGRAPHIC DISTRIBUTION

Lechriodus fletcheri is found in New Guinea and in the mountains and coastal districts of eastern Queensland and eastern New South Wales (fig. 6). Its known altitudinal range extends from near sea level to 3000 feet. The most northern Australian record is Ravenshoe, Queensland, and the southern limit is Ourimbah, New South Wales. The type locality is Dunoon on the Richmond River in New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Dunoon (No. 8330, a cotype)
Lowanna, near Dorrigo (Nos. 12618-12634)
Ourimbah (No. 4694)

New South Wales localities reported by other authors, in addition to those just listed, are as follows: Ulong (Slevin, 1955); Salisbury, 1000 feet (Loveridge, 1935); Cascade, 3000 feet (Loveridge, 1935).

QUEENSLAND RECORDS

The American Museum of Natural History has specimens from:

Ravenshoe (No. 19947)
Binna Burra, Beechmont (No. 58953)

Andersson (1916) lists a specimen (as *Phanerotis fletcheri*) from Mt. Tambourine.

NEW GUINEA RECORDS

Literature records for New Guinea are given in van Kampen (1923, as *Phanerotis fletcheri*), H. W. Parker (1940), and Loveridge (1956).

COMMENTS

The tadpoles of this species seem to eat eggs of their own species in nature. In the

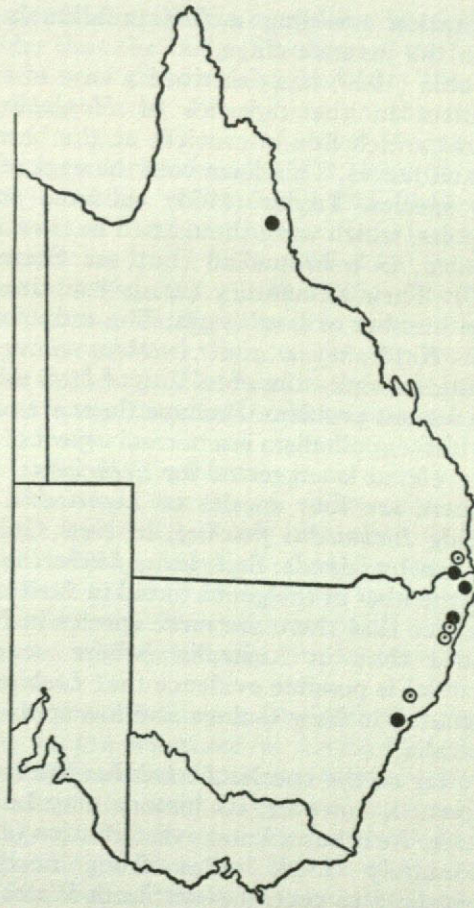


FIG. 6. *Lechriodus fletcheri*. Geographic distribution.

laboratory they eat tadpoles of their own or other species. Cannibalism may be a normal and necessary feature of the life history of *Lechriodus fletcheri*. The breeding sites of this species at Binna Burra, Queensland, which I observed, and those at Ulong, New South Wales, described by Slevin (1955), were very small pools and puddles. The available food supply would surely not be sufficient for several hundred tadpoles to reach metamorphosis. Methods of adaptation to situations of this sort would be for the female to produce many eggs but deposit only a few in each puddle or to produce a few eggs with a large amount of stored food materials. *Lechriodus fletcheri* has perfected neither of these methods of circumventing overcrowding, but instead deposits many eggs of which most will be eaten. Cannibalism would then be an

adaptation enabling a few individuals to reach the juvenile stage.

Noble (1929) has described a case of cannibalism in the tadpoles of *Hoplophryne rogersi*, which live in crevices at the base of banana leaves. This form eats the eggs of its own species. Taylor (1954) collected some tadpoles, which were thought to be *Anotheca coronata*, in a bromeliad (but see Starrett, 1960). Their alimentary canals contained a large number of frog's eggs. The tadpoles of both *Hoplophryne* and *Anotheca* occur in situations where the obtaining of food might be a serious problem. Perhaps these are cases in which cannibalism is a normal aspect of the life cycle, as is suggested for *Lechriodus*.

There are four species of *Lechriodus*, including *Lechriodus fletcheri*, in New Guinea and nearby islands. *Lechriodus fletcheri* is the only member of the genus found in Australia. The fact that there are more species in New Guinea than in Australia (where none is endemic) is possible evidence that *Lechriodus* originated in New Guinea and has spread to Australia.

So far as the species *Lechriodus fletcheri* is concerned, however, its history may be the reverse. As it has a known distribution of approximately 1300 miles from northern Queensland to central New South Wales, we may assume that the species has been in Australia for a long period of time. Perhaps its ancestor was a different species which invaded Australia from New Guinea and evolved into *Lechriodus fletcheri* in Australia. If this interpretation is correct, the *Lechriodus fletcheri* of New Guinea represents an invasion from Australia to New Guinea. These are interesting problems, but speculation of this type should not be taken too seriously, because many interpretations are possible, and the existing data do not permit a final answer.

LITERATURE

This species was first described by Boulenger (1890) who placed it in a new genus, *Phanerotis*. He believed this genus was closest to *Adelotus* and that it showed affinities to *Limnodynastes* as well. The type is in the British Museum (Natural History). General descriptions, which include distribution records, using the name *Phanerotis fletcheri*, are

given by Lucas and Le Souëf (1909), Fry (1915, with figures of the head and open mouth), Andersson (1913b; 1916, with figures of the adult, the tongue, and sternum) and van Kampen (1923). Nieden (1923) describes this form, using the name *Ranaster fletcheri*. H. W. Parker's (1940) and Slevin's (1955) descriptions use the name *Lechriodus fletcheri*.

Geographical data are given by Fletcher (1890 and 1894b, as *Phanerotis fletcheri*) and Loveridge (1935).

Minor mention is made by Fry (1912, as *Phanerotis fletcheri*), Roux (1920, as *Phanerotis fletcheri*), and Loveridge (1945).

Adelotus brevis (Günther)

THE TUSKED FROG

Plate 34, figures 2, 4; text figures 7, 8

DIAGNOSIS

Males can be distinguished from those of all other species in eastern New South Wales by the tusks of the lower jaw. Females, as well as males, can be distinguished from other species by the general dark coloration of the body combined with the orange-red areas on the hind legs. They could be confused only with *Crinia haswelli*, which also has a reddish coloration on the hind legs. *Crinia haswelli*, however, is a smaller species (maximum sizes: *Crinia haswelli*, 32 mm.; *Adelotus brevis*, 50 mm.), and it has a prominent dark line that extends from the eyes (in some specimens, the nose) back to the level of the arms. This line is lacking in *Adelotus brevis*. The peculiar butterfly-shaped spot between the eyes of *Adelotus brevis* will identify most specimens. This feature is especially useful in preserved material, because the red of the hind legs is generally destroyed by the preserving fluids.

DESCRIPTION

The general impression given by this species is of a medium-sized, rough-skinned, darkly colored frog. At times the dorsal surface is so dark that practically no pattern can be distinguished. Under these conditions the most constant features are some indistinct bars on the appendages and a brownish area that begins at the level of the eyes and extends to the tip of the snout. In individuals with more contracted melanophores, a dorsal

pattern can be distinguished. In this condition the background color is dark olive-green or grayish olive, and, in addition, there are large elongate black markings that may take the form of irregular V's, with the apex of the V directed anteriorly.

Nearly all individuals have a black, butterfly-shaped spot that begins at the eyes and extends posteriorly for a distance equal to the diameter of the eye. One specimen in the 21 that I have collected has a light median stripe. The cross bars on the appendages are irregular. The upper jaw has large dark areas alternating with narrow light areas.

The most colorful feature of these frogs is the orange-red areas on the hind legs. These are on the posterior surface of the tibial segment and on the anterior surface of the thigh, at its junction with the body. In a few specimens the distal third of the posterior surface of the thigh and the dorsal surface of the foot are similarly colored.

In most specimens the dorsal surfaces of the fingers and toes are cross-barred with wide black bands and narrow white bands.

In both sexes the throat has minute white spots on a background that is grayish brown or nearly black. The ventral surfaces of the abdomen and of the appendages are black, with white spots or large white blotches. The males tend to be darker below than the females. The females frequently have a striking black and white marbling similar to that of *Pseudophryne australis* (pl. 40, figs. 2, 3).

The dorsal surface may be nearly smooth or have ridges and small warts. A light brown glandular fold extends from the eyes to the attachment of the arms. The ventral surface of the foot and the tibial segment of the leg always have small warts. The ventral surface of the body is smooth.

Adelotus brevis is a moderately dumpy frog. Males are of greater average size than females, an unusual situation in frogs. The mean body length of 14 males collected at breeding sites in Ebor, New South Wales, and Binna Burra, Queensland, is 39.2 (range, 34.2–43.5) and, of seven females from Binna Burra with spatulate fingers, 33.5 (range, 29.1–38.0). The largest specimen I have seen is a male in the Australian Museum (No. 7621) measuring 50.5 mm. in body length.

The shape of the body differs in the two

sexes. The male has a massive head that is wider than the body. The head of the females is less than the width of the body. There is a striking sexual dimorphism in the relative head length. The mean head length/body length ratio for females is 0.38 ± 0.01 (0.36–0.39) and for males 0.50 ± 0.02 (0.47–0.53). The mean head width/head length ratio for females is 1.02 ± 0.03 (0.98–1.08) and for males 0.97 ± 0.02 (0.92–1.00). The head width/head length ratios give a very misleading indication of the way the two sexes appear to the eye. The head of the male is wider than that of the female, but, inasmuch as its length is so much greater, the head width/head length ratio is actually lower.

The legs are short. The mean tibia length/body length for the same 21 specimens is 0.43 ± 0.01 (0.41–0.44) for the females and 0.42 ± 0.01 (0.39–0.43) for the males.

In most specimens the tympanic membrane is not visible externally, but in a few it is indistinct.

The fingers have a vestigial web (fig. 7). The length sequence is $3 > 2 \geq 4 > 1$. There are two well-developed metacarpal tubercles. The first and second fingers of the female are fringed, a feature correlated with the habit of depositing a foam nest for the embryos.

The web of the toes is vestigial, all four joints of the fourth toe being free (fig. 7). There are a small inner metatarsal tubercle and an outer metatarsal tubercle that is small and indistinct.

The vomerine teeth are in two small clusters posterior to the choanae (fig. 7). The tongue is moderately broad.

A striking feature of *Adelotus brevis* is the presence of two large, bony, tusk-like structures in the lower jaw of the male. These may be as much as 2.5 mm. in length and they are sharp. The female has vestiges of these structures. Noble (1922, pp. 7–11; 1931, pp. 124–125, fig. 40B) has described similar structures in other frogs. The functions of these pseudo-teeth is unknown.

HABITAT

This species occupies a variety of habitats ranging from large streams to small puddles. In all of them it tends to be secretive, even at night. In Guy Fawkes Creek at Ebor, New South Wales, it was found in sheltered cavi-

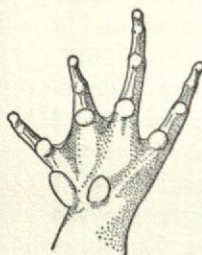
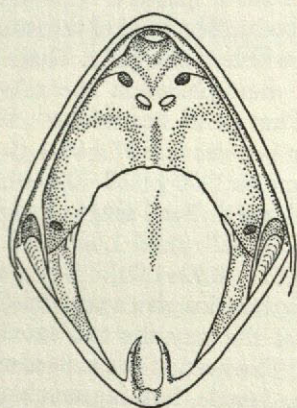


FIG. 7. *Adelotus brevis*. Open mouth, hand, and foot.
A.M.N.H. No. 59092. Ebor, New South Wales.

ties under the banks of the stream and under overhanging rocks (pl. 28, fig. 1). At Binna Burra, Queensland, adults were found along the Coomera River (pl. 27, fig. 1) and in a swamp (pl. 32, fig. 1). In this last situation they were in shallow water under logs or in the holes made by the feet of cattle.

VOICE

One call of the male is a gentle, clucking "glk," which is given at the rate of about four per minute. Another call can be imitated, though poorly, by placing the tip of one's tongue on the roof of the mouth and trilling a "dk-dk-dk" about six times. The males were heard calling at night as well as during the day. Frequently they were found floating in the water with only the anterior part of the body exposed. They were not observed calling in open water but only in crevices in the bank, under overhanging rocks at the edge of streams, or in holes.

BREEDING HABITS

I have observed *Adelotus brevis* breeding at Ebor, New South Wales, and Binna Burra, Queensland.

At Ebor breeding was occurring November 20–21, 1952, in Guy Fawkes Creek (pl. 28, fig. 1). The water temperature was 22° C. This stream is about 15 to 20 feet in width and varies in depth from a few inches to a few feet. Two masses of freshly deposited eggs were found, and in both instances they were hidden. The spawn was floating on the water

beneath an overhanging rock or in a crevice in the undercut bank. The space above the mass was not more than several inches in height, and the sites were protected from the sun. In both cases a male was with the egg mass, a type of behavior recorded for aquarium animals as well (K. Deckert, 1929). Individual males were found in similar places under overhanging rocks or back under the bank.

At Binna Burra breeding was taking place December 16–18, 1952, in two different habitats. One was in shallow water at the edge of a swamp (pl. 32, fig. 1). Eight egg masses were under the partially submerged log shown in the photograph. Individual males were abundant, and they were generally in holes made by cattle hoofs, especially in those partially covered by grass. The other breeding situation was a small stream about a yard wide and several inches deep. A clasping pair was caught in the overhanging vegetation growing in the edge of the stream. The water temperature was 16° C. The secretive habits of the males of this species remind one of *Limnodynastes peroni*.

The eggs are deposited in a foam mass measuring about 5 by 10 cm. (pl. 34, fig. 2). In general appearance this resembles the egg masses of *Limnodynastes peroni*, *Limnodynastes tasmaniensis*, and *Lechriodus fletcheri*. They can be distinguished from those of the just-mentioned species by the lack of pigment in the eggs. In fact, the early embryos of *Adelotus brevis* are so pale that it is difficult to

see them in the foam mass. The other foam-nest builders just mentioned have eggs with black animal hemispheres. The entire mass floats on the surface, and most of the embryos are situated near the top of the mass, where they are afforded a maximum concentration of oxygen and are protected from many aquatic predators.

All the egg masses that I encountered were in well-shaded situations. It would be of interest to know if the unpigmented embryos, which are placed near the top of the foam mass, would survive if exposed to direct sunlight.

EMBRYONIC DEVELOPMENT

Two groups of *Adelotus brevis* embryos were studied. The first group was obtained from a natural spawning at Ebor, New South Wales. The second group was obtained from the artificial fertilization of ova from a gravid female collected at Binna Burra, Queensland, on December 18, 1952. Nearly all the observations that follow were made on the first group. Neither group was maintained at a constant temperature, but the average was about 20° C. The times given for development, therefore, are of limited usefulness.

The eggs are about 1.8 mm. in diameter and creamy white, with little or no difference between the animal and vegetal hemispheres in pigmentation. The cleavage, blastular, and gastrular stages are essentially as in the typical ranas. In the neurular and later stages minor differences appear. For example, the anterior portion of the neural folds of *Adelotus brevis* are narrower and, by the time the embryos are in stage 18, the head, the dorsal portion of the trunk, and the tail are rather well separated from the still circular yolk mass.

When the embryo is about five days old and 4.5 mm. in length, it is indeed a beautiful sight for an embryologist. There is no dark pigment, and the epidermis is so transparent that the heart, which is contracting at this time, is clearly visible. The optic cup, lens, and otic vesicle can also be seen readily in the living embryo. External gills are not formed, but four aortic arches are clearly visible, as the blood is pigmented by this time. The head projects forward more than is usual for *Rana*, and the tail bends dorsally to a considerable degree.

Melanophores were first noticed when the embryo was 5.2 mm. in length and six days old. They appear first on the head and anterior body region. The melanophores are striking against the otherwise pigmentless skin. Hatching begins at about this time but even when the embryo leaves its individual jelly capsule it remains within the surrounding jelly mass, which is very sticky and fluid.

The week-old embryo is 7 mm. in length. It is still largely without pigment, even though the melanophores are becoming more numerous and are migrating ventrally from the dorsal portion of the embryo. The development of the operculum begins at this time.

The 16-day tadpoles are about 12 mm. in length. The tail is lightly pigmented, but the body is heavily pigmented. The most striking aspect of the pigmentation is the chromatophores, which are a metallic golden green.

When the tadpole is eight weeks old, the body length is about 21 mm. The anus opens to the right of the midline, and the spiracle is on the left. The mouth is almost terminal. It is surrounded by a corona of papillae, which is complete except for a short gap on the dorsal side. Transformation began in these embryos after they had been in the laboratory for 71 days. The maximum length attained by the tadpoles was 28 mm.

An interesting color dimorphism was noticed in the tadpoles. Of 81 individuals examined when they were 46 days old, all but 16 had a light-colored patch on the snout. The position and shape of this patch remind one of the patch on the snout of the adult. The two sorts of tadpoles were separated. Those with the patch transformed into adults with a prominent snout patch and those with no patch became adults without a patch or with a very faint one.

GEOGRAPHIC DISTRIBUTION

Adelotus brevis occurs in the mountains and coastal regions of southeast Queensland, New South Wales, and possibly in Victoria (fig. 8). The type locality is the Clarence River of New South Wales. The altitudinal range is from near sea level to 4200 feet (Ebor, New South Wales). Andersson's (1913a) record from Yandina, Queensland, is the most northern. The southernmost record is Springwood, New South Wales, or possibly

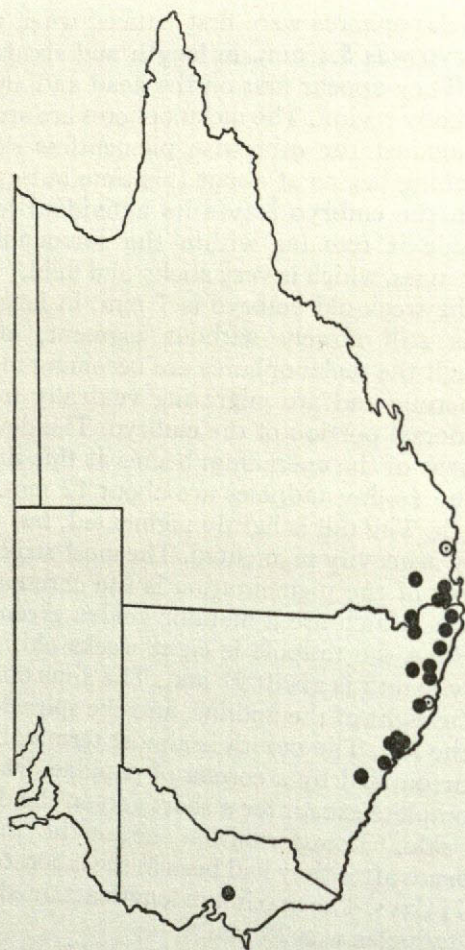


FIG. 8. *Adelotus brevis*. Geographic distribution.

Healesville, Victoria. The Dividing Range marks the general western limit, there being few records from areas farther west.

Adelotus brevis is not found in the Sydney region. Gosford and the Blue Mountains are the nearest localities where it occurs.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Tweed River (Nos. 8488, 8489)
- Copper's Creek, Huonbrook (Nos. 11863-11867)
- Richmond River (Nos. 5068-5074)
- Lismore (Nos. 5441, 5442)
- Ballina (No. 330)
- Tenterfield (No. 13112)
- Clarence River (Nos. 6902, 6904, 6906, 6908)
- Lowana (Nos. 12639-12641, 12648, 12649)
- East Dorrigo (Nos. 9985-9987)
- Warrel Creek (Nos. 4248, 4249)

- Gurravembi (Nos. 6299, 6300)
- Nambucca River (No. 5882)
- Comboyne (No. 11382)
- Upper Chichester (No. 7621)
- Myall Lakes (No. 11663)
- Bulahdelah (Nos. 8090-8091)
- William's River (Nos. 9221-9223)
- Wyong (No. 13072)
- Gosford (Nos. 4229, 9901)
- Springwood (Nos. 1449, 5094)

The American Museum of Natural History has specimens from:

- Lismore, Richmond River (Nos. 13342, 13343)
- Clarence River (No. 23572, topotype)
- Nambucca River (Nos. 13340, 13341)
- Ebor (Nos. 59090-59094)

The only literature record of a locality essentially different from the ones listed above is Port Macquarie (H. W. Parker, 1940).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

- Brisbane (Nos. 4308-4319)
- Toowoomba (No. 5515)
- Pimpama (No. 7408)
- Mt. Tambourine (Nos. 8451, 8452)
- East of Wallangarra (No. 13113)

The American Museum of Natural History has specimens from:

- Binna Burra, Beechmont (Nos. 59095-59108)

The only literature record of a locality essentially different from the ones listed above is Yandina (Andersson, 1913a).

VICTORIA RECORD

The Australian Museum has a specimen from Healesville (No. 9499). This locality is approximately 400 miles southwest of Springwood, the southernmost locality in New South Wales. The specimen is well preserved, and there is no doubt of the identification. If the locality is correct, this is a considerable extension of the known range. I feel that this record should be questioned until more material is obtained, especially as there is a zoo at Healesville.

LITERATURE

Adelotus brevis was described and figured under the name *Cryptotis brevis* (Günther, 1863a). The cotypes are in the British

Museum (Natural History). The present generic name, *Adelotus*, was proposed by Ogilby (1907) as a substitute for the preoccupied *Cryptotis*. Apart from this paper by Ogilby, all citations from 1863 through 1913 use the original name. *Adelotus brevis* is used after 1913. Other descriptions, including distribution data, are given by Steindachner ("1869" [1867]), Keferstein (1868a), Lucas and Le Soüef (1909), Nieden (1923, with a drawing of the adult and of the palatal region), H. W. Parker (1940, with a drawing of the anterior cranial elements), and Slevin (1955, with a photograph of a preserved specimen).

Notes on geographic distribution are given by Krefft (1865 and 1867), Fletcher (1889, 1890, 1892, and especially 1894b), Boettger (1892), Andersson (1913a), and Loveridge (1935).

The depressor mandibulae muscle is described by Griffiths (1954), and mention is made of the vertebrae by Nicholls (1916).

Klingelhöffer (1931 and 1956) described the behavior of *Adelotus brevis* in the terrarium.

There is a minor mention of the species in Fry (1912).

Heleioporus australiacus (Shaw)

THE GIANT BURROWING FROG

Plate 35, figure 1; text figures 9, 10

DIAGNOSIS

The large size, toad-like body form, uniformly colored upper parts, and the presence of a small flap at the anterior corner of the eye separate *Heleioporus australiacus* from all other frogs in eastern New South Wales. The species it resembles most closely is *Limnodynastes dorsalis*. *Heleioporus australiacus* lacks the prominent gland on the tibia that is characteristic of *Limnodynastes dorsalis*. The pupil of *Heleioporus australiacus* is a vertical slit, whereas it is nearly circular in *Limnodynastes dorsalis*. Males of *Heleioporus australiacus* can be readily identified by the prominent, cone-shaped, nuptial spines on the fingers (fig. 9). These are lacking in *Limnodynastes dorsalis*. As a further check, the first finger is longer than the second in *Heleioporus australiacus*. The reverse is true for *Limnodynastes dorsalis*.

DESCRIPTION

The upper parts, including the appendages, vary from a deep chocolate brown to a grayish brown. Individuals are usually uniformly colored, but on some there are indistinct dark spots. The edge of the upper jaw is slightly lighter in color. There is a prominent yellow ridge, made up of a series of warts, that begins on the hind part of the upper jaw and extends posteriorly for about 1 cm. The sides of the body are paler than the back. The back and sides are covered with numerous warts, each tipped with a tiny black spine. Many of the warts on the sides are yellow.

The under parts, including the appendages, are bluish white. These areas are smooth, except for the throat and anterior chest regions which are sprinkled with minute whitish warts, which are tipped with tiny black spines.

There are numerous large whitish warts in the cloacal region.

Heleioporus australiacus is a large species having a broad body and short legs. The Australian Museum has nine males from the vicinity of Sydney, New South Wales. These vary in body length from 59.2 to 93.4 mm. The body length of four females in the same collection varies from 69.0 to 78.0 mm. The mean tibia length/body length ratio for these males is 0.35 ± 0.01 (0.33–0.37) and for the females 0.33 ± 0.00 (0.33–0.34).

The mean body proportion ratios of two mature males (67.0 and 79.7 mm. in body length) and one mature female (73.0 mm. in body length) in the American Museum of Natural History are: tibia length/body length, 0.36 (range, 0.35–0.39); head width/head length, 1.23 (range, 1.22–1.24); head length/body length, 0.36 (range, 0.35–0.38).

The pupil is a vertical slit (pl. 35, fig. 1). The iris is silvery, with irregular black lines extending throughout. There is a small flap of skin at the anterior edge of the eye.

The tympanic membrane is circular and fairly prominent.

The fingers are not webbed (fig. 9). The length sequence is $3 > 1 > 2 > 4$. The males have an impressive array of hard, black, nuptial spines on the first three fingers. The largest, which is on the thumb, is cone shaped, and it may be 5 mm. in length and 3

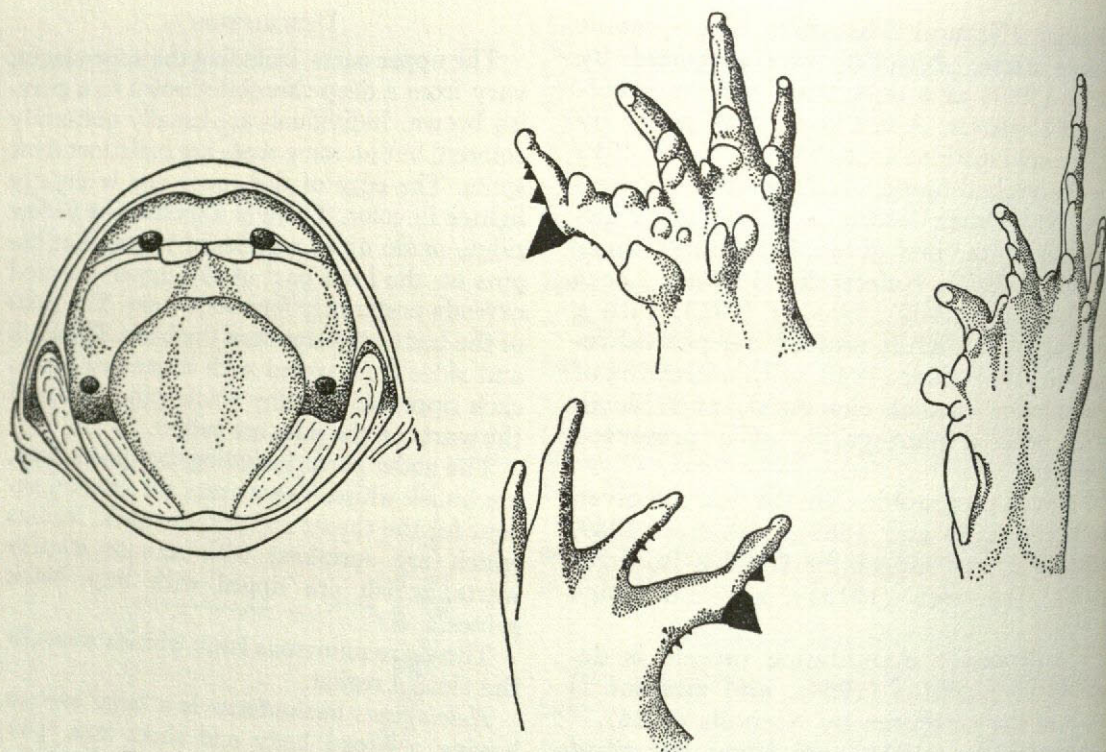


FIG. 9. *Heleioporus australiacus*. Open mouth, two views of the hand, and foot. A.M.N.H. No. 59110. Killara, New South Wales.

mm. in diameter at the base. The degree of development seems to vary and is probably correlated with the hormonal cycles. These spines are lacking in the female. An additional sexual difference is the size of the arms. Those of mature males are greatly thickened.

The posterior portion of the sternum, which is V-shaped, with the two arms of the V directed posteriorly, can be seen clearly through the skin of the living animal.

The toes have a rudimentary web, four joints of the fourth toe being free (fig. 9). The webs between all but the two outer toes have swellings along the margin. There is a large inner but no outer metatarsal tubercle.

The tongue is broad (fig. 9). The vomerine teeth are in two prominent transverse series that extend from the midline to the posterior median border of the choanae.

HABITAT

All New South Wales specimens are from localities within 60 miles of Sydney and nearly all from the geological formation known as the Hawkesbury Sandstone. This is a burrowing species, and the males call from underground. A favorite place for them near

Killara, New South Wales, is in sandstone cliffs, where they burrow in the earth between the rocks. In this situation as many as three males may be heard calling at any one time. The adults are not frequently met with above ground. I have seen one male hopping along the road and another male in a deep rain-water pool, both situations near the cliffs mentioned.

VOICE

The call is a soft, owl-like "ou-ou-ou."

BREEDING HABITS

In April, Fletcher (1894c) found spawn, which he believed to belong to this species, in a hole in the bank of a creek. I have heard males calling during August, September, and March but not in late spring or summer. These observations may indicate that breeding occurs during the cooler months. Dakin (1920) has described the breeding of a closely related species in Western Australia.

EMBRYONIC DEVELOPMENT

The egg mass observed by Fletcher (1894c) was large and frothy. The embryos resembled

those of *Pseudophryne* (?*australis*) in being large and in having a yolk sac. External gills were present. Fletcher does not mention raising the embryos to metamorphosis in order to check their identity, so there must always be some doubt whether he was describing *Heleioporus australiacus* or some other species.

The ovarian eggs are huge, being approximately 2.5 mm. in diameter. The upper two-thirds of the animal hemisphere is very dark. Below this the egg becomes increasingly lighter colored towards the vegetal pole. The line of demarcation between the light and dark areas is very sharp.

I collected a single tadpole at Killara, New South Wales. The body is light in color, the predominating pigment cells being golden ones. When viewed from the dorsal side, with the unaided eye, the epidermis has a greenish

metallic sheen. The tail appears colorless, but under the microscope both golden pigment cells and melanophores can be seen to be present. The iris is black, with golden cells in all but the dorsal median portion. The spiracle is on the left side. A length of 75 mm. is reached before metamorphosis.

This recently transformed juvenile was 15.7 mm. in length. In coloration it resembled the adult, except that the black was covered with small black spots, and the warts, which are yellow in the adult, were whitish at this stage. The tympanic membrane was not visible.

GEOGRAPHIC DISTRIBUTION

The range of *Heleioporus australiacus* is a remarkable example of disjunct distribution (fig. 10). This species occurs in a small area in and around Sydney, New South Wales, and

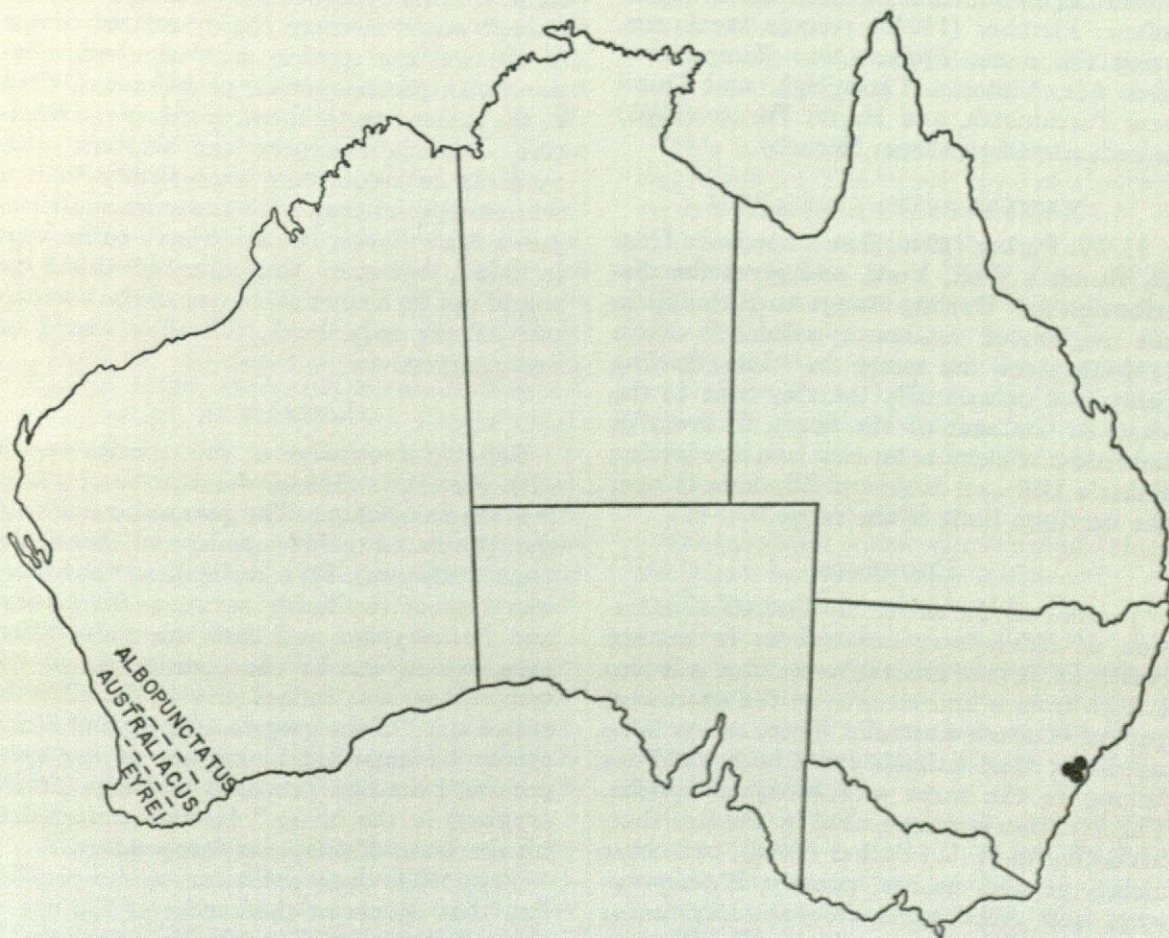


FIG. 10. *Heleioporus australiacus* and allied species. Geographic distribution.

in another small area in the southwest part of Western Australia. The type locality is New Holland.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Lindfield (Nos. 966, 4590, 5508, 6067)
 Leura (Nos. 1929, 8462-8465)
 Lawson (No. 2405)
 Kingswood, near Penrith (No. 6272)
 Hazelbrook, Blue Mountains (No. 8392)
 Gosford (No. 9470)
 North of Sydney (No. 5958)

The American Museum of Natural History has specimens from:

Killara (Nos. 59109, 59110)
 French's Forest, near Sydney (No. 59111)

New South Wales localities reported in the literature, in addition to those listed above, follow: Fletcher (1894c) records specimens, using the name *Philocryphus flavoguttatus*, from Mt. Victoria, Thornleigh, and Dural near Parramatta, and H. W. Parker (1940) records a specimen from Hornsby.

WESTERN AUSTRALIA RECORDS

H. W. Parker (1940) lists a specimen from St. Ronan's Well, York, and gives the distribution as "Darling Range to Karonup in the region of moderate rainfall." Main (1954a) gives the range as "The Darling Scarp and occasionally the clay zone to the west, to the east of the Scarp in areas of laterites and clays as far east as a line joining Baker's Hill and Karonup. Bindoon is near the northern limit of the range."

COMMENTS

In view of the extremely limited distribution of *Heleioporus australiacus* in eastern Australia, it is of great interest that it is also known from a limited area in the southwest part of Western Australia. There seems to be no doubt that animals from both localities belong to the same morphological species. The situation is complicated by the fact that, according to H. W. Parker (1940), two other closely related species, namely, *Heleioporus eyrei* and *Heleioporus albopunctatus*, occur with *Heleioporus australiacus* in Western

Australia. He writes, "in West Australia the three form a complex, of which *eyrei* occupies the dry zone to the west of the Darling Range, *australiacus* the relatively damp areas on both sides of the mountains and *albopunctatus* the dry zone to the east."

More recently Lee and Main (1954) have described two additional species from Western Australia, *Heleioporus psammophilus*, which is similar in *Heleioporus eyrei*, and *Heleioporus inornatus*, which is similar to *Heleioporus albopunctatus*.

With so many similar species existing in the southwestern corner of the continent, one should certainly question whether or not the populations of *Heleioporus australiacus* from the east and west belong to the same biological species. Perhaps the western *Heleioporus* assigned to *australiacus* merely represent a parallel development in the west of a type similar to the New South Wales form. On this hypothesis the western "*australiacus*" would be more closely related to one of the western species, such as *eyrei*, *albopunctatus*, *psammophilus*, or *inornatus*, than to the eastern *australiacus*. If this is the situation, we might expect the western *australiacus* to cross more successfully with a western species than with the eastern *Heleioporus australiacus*. It would have to be kept in mind, however, that data of this type would not be a conclusive test of the correctness of the hypothesis, but they would be most suggestive.

LITERATURE

Reliable knowledge of this species begins with Fletcher's (1894c) description of *Philocryphus flavoguttatus*. The genus also was new, though related to *Heleioporus* and *Chiroleptes* (now *Cyclorana*). Fletcher realized that there was a great similarity between *Heleioporus* and *Philocryphus* and that the main difference, which was in the distinctness of the tympanum, was indeed trivial. In 1898 he stated that "if the generic definition of *Heleioporus* be amended in respect of the tympanum, I am now prepared to merge (*Philocryphus*) in the latter." He then referred to his species as *Heleioporus flavoguttatus*.

Fry (1914) drew attention to the peculiar flap that occurs at the corner of the eye in this species and to a similar structure in

Heleioporus albopunctatus. Fry thought it better not to include *flavoguttatus* in *Heleioporus*, however, but to maintain the separate genus *Philocryphus*, because there was a distinct difference in the tympanum and the shape and degree of ossification of the sternum. In 1915 Fry pointed out that the long-forgotten *Rana australiaca* of Shaw (1795) was probably the same as Fletcher's *Philocryphus flavoguttatus*.

More recently *Philocryphus* was merged with *Heleioporus*, as Fletcher suggested, and *flavoguttatus* has been replaced by *australiacus*, so the proper designation for the species is *Heleioporus australiacus*.

General descriptions, which frequently include data on distribution, are given by Fletcher (1894c, as *Philocryphus flavoguttatus*; and 1898, as *Heleioporus flavoguttatus*), Lucas and Le Souëf (1909, as *Philocryphus flavoguttatus*, with a side view of the head showing the eye flap, a ventral view of the sternum, the dorsal and lateral views of the terminal phalanx of the fourth toe), Fry (1915, as *Philocryphus australiacus*), Nieden (1923, as *Heleioporus flavoguttatus*), H. W. Parker (1940), Main (1954a), and Moore (1957a, with a photograph of the adult).

Keferstein's (1868a) "*Heleioporus albopunctatus*" must be *Heleioporus australiacus*, if his specimens really were from Sydney as stated (but see Fletcher, 1894c). He gives figures of the adult, pectoral girdle, and skull.

Data on distribution are also given by Fletcher (1889, 1890, as *Heleioporus albopunctatus*; 1894b, as *Philocryphus flavoguttatus*), Loveridge (1935, as *Philocryphus australiacus*), and Main, Lee, and Littlejohn (1958).

Notes on the habits of this species are given by Fletcher (1889, as *Philocryphus flavoguttatus*), Steel (1912, as *Philocryphus flavoguttatus*), and Harrison (1922, as *Philocryphus australiacus*).

Bentley, Lee, and Main (1958) studied resistance to desiccation, and Main, Littlejohn and Lee (1959) studied breeding behavior, burrowing, and adaptation to arid conditions. Littlejohn and Main (1959) have studied the call of the male.

Minor mention of this species is made by Barrett (1943, as *Philocryphus flavoguttatus*).

I have never found a reference to the existence of the type of *Rana australiaca*.

Neobatrachus pictus Peters

THE SPOTTED BURROWING FROG

Plate 35, figure 2; text figures 11, 12

DIAGNOSIS

The vertical slit pupil (pl. 35, fig. 2), in addition to the prominent black inner metatarsal tubercle, distinguishes this species from all others in eastern New South Wales.

DESCRIPTION

In life the back is greenish, with large dark green or black blotches. In some specimens there is a trace of a light middorsal stripe. The coloration of the upper part of the appendages is the same as the ground color of the back. The posterior part of the thigh is dark brown, with a few small light green spots. A wide and slightly curved dark band extends from the snout to the eye, and there is a large dark spot between the eyes. The skin of the upper parts is roughened with small tubercles.

The under parts are smooth and white, except for the edge of the lower jaw, which is spotted with brown.

This is a small, moderately stout, short-legged species. The largest specimen known to me is a male from Canberra (A.M.N.H. No. 59114) with a body length of 50 mm. Four breeding males (A.M.N.H. Nos. 59112-59114 plus one unnumbered) from this locality average 45 mm. in body length. The mean body proportion ratios for these are as follows: tibia length/body length, 0.34 (range, 0.33-0.35); head width/head length, 1.16 (range, 1.13-1.20); head length/body length, 0.34 (range, 0.34-0.35).

The pupil is a vertical slit.

The tympanic membrane is not prominent, but it can be seen in most specimens.

The fingers lack webs (fig. 11). Their length sequence is $3 > 1 > 2 > 4$ or $3 > 1 > 2 = 4$. In males there is a nuptial pad in the form of a dark brownish area, composed of microscopic tubercles, on the inner side of the thumb. Apparently this is not always present in breeding males.

There is a well-developed web extending nearly to the tips of the toes, and the fourth toe has only two joints free (fig. 11). The web is deeply indented between the digits and, as a result, the foot has a characteristic scalloped

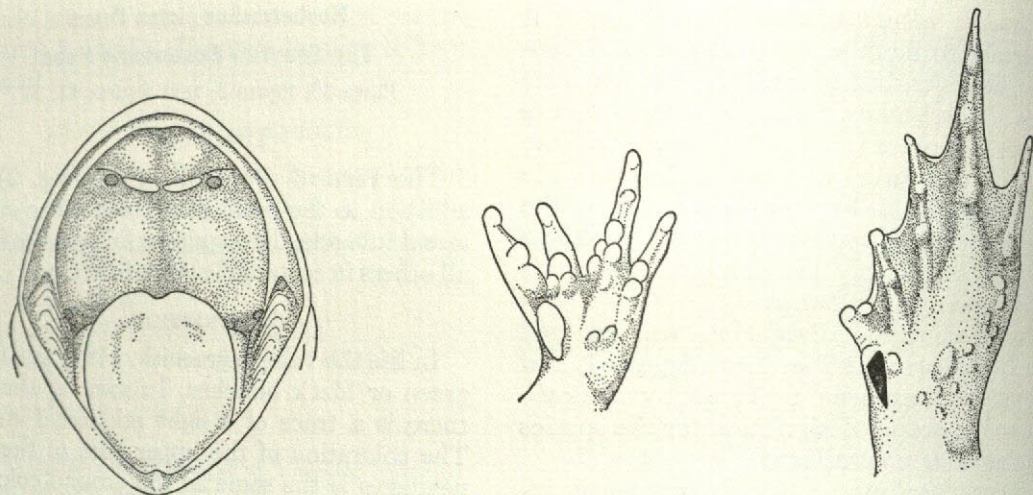


FIG. 11. *Neobatrachus pictus*. Open mouth, hand, and foot. A.M.N.H. No. 59113. Mt. Stromlo, Australian Capital Territory.

appearance. There is a prominent black inner metatarsal tubercle, which is a character of importance in the recognition of this species.

The tongue is broad and has a shallow notch on the posterior border (fig. 11). The vomerine teeth are well developed. They are arranged in two transverse series that touch at the midline and extend laterally to the internal openings of the nostrils.

HABITAT

Neobatrachus pictus, and closely similar forms (species or subspecies), extend from the Dividing Range in the east across the continent to the west coast. This range encompasses a variety of habitats, from those with moderate amounts of moisture to deserts. It is found in the 30-inch rainfall belt (Mt. Stromlo, Australian Capital Territory) and in areas of western New South Wales and central Australia where the annual rainfall is well below 10 inches. This is a burrowing species and in areas of low rainfall it estivates for much of the time and appears only after heavy rains. Spencer (1896b) has described the habits of this or a closely similar species in the dry areas of central Australia. [It should be added, however, that H. W. Parker (1940) believes these centralian forms to belong to a different species, *Heleioporus centralis*. Its current name would be *Neobatrachus centralis*, but I do not think a convincing case has been made for its specific distinctness.]

VOICE

The call is a faint buzzing noise. Peters (1863) described it as being much like the cry of a kitten.

BREEDING HABITS

I have found adult males and recently deposited embryos of this species on Mt. Stromlo, Australian Capital Territory, on October 25, 1952. The embryos were in early cleavage stages. They had been deposited in a low grassy area (pl. 29, fig. 2) that in wet weather becomes a slow-flowing stream. The embryos were in 1-3 inches of water, and the water temperature was 12° C.

EMBRYONIC DEVELOPMENT

The following observations were made on *Neobatrachus pictus* embryos collected at Mt. Stromlo, Australian Capital Territory, on October 25, 1952. They were blastulae when collected, but examination with a microscope did not begin until the third day, when they were neurulae.

The stage-16 embryo has a length of 2.5 mm. and a width of 1.2 mm. The color is a rich brown. The embryo could pass for a typical *Rana* except for its possession of a prominent transverse glandular area on the anterior-dorsal aspect of the head. When the embryos are in stage 19, these frontal glands are part of a ridge that extends across the head from one olfactory pit to the other. As a

consequence the embryos seem to have a prow when viewed laterally.

External gills are formed, and later these are covered by the operculum. When fully formed the operculum opens to the left. The anus opens to the right.

When the horny teeth are fully formed, there are one continuous and two interrupted rows above the mouth and one interrupted and two continuous rows below the mouth. The mouth is subterminal. There are a complete row of papillae on the lower jaw and a short row on the sides of the upper jaw.

The dorsal side of the body of the fully formed tadpole has a complete layer of melanophores, together with a few golden chromatophores. The tail is heavily pigmented in the myotome region, and the fins have clumps of melanophores in addition to

streaks of melanophores along the blood vessels. The skin of the ventral side of the body contains an almost continuous layer of golden chromatophores in the posterior portion, but the anterior portion is transparent.

In the laboratory the tadpoles grew to a maximum size of 56 mm. Transformation began, that is, the front legs emerged, on the eighty-sixth day.

GEOGRAPHIC DISTRIBUTION

Neobatrachus pictus extends from Warwick and Birdsville in Queensland, south through New South Wales (west of the Dividing Range) to Melbourne in Victoria, and west to Adelaide in South Australia (fig. 12). Similar forms occur in central Australia and in Western Australia, but further data are necessary before the relations of these vari-

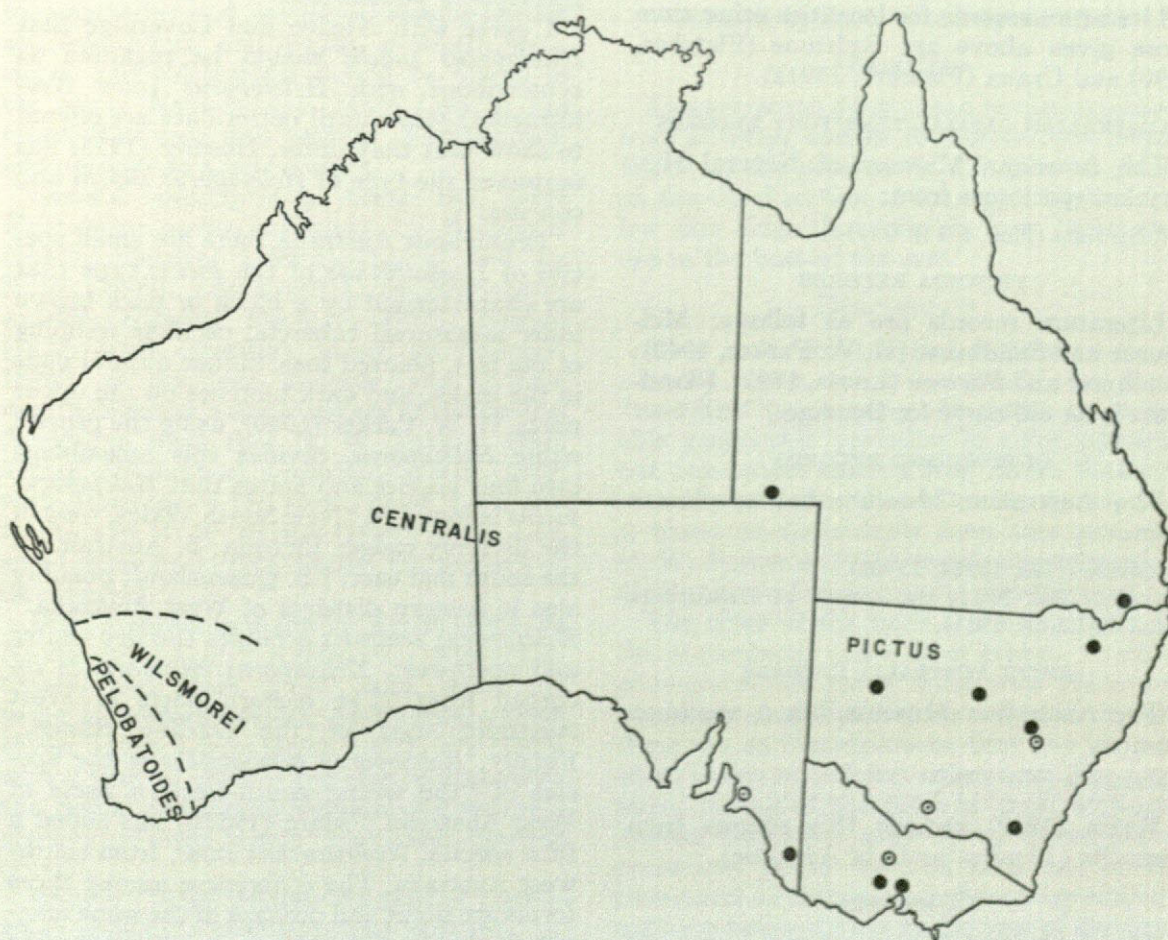


FIG. 12. *Neobatrachus pictus* and allied species. Distribution of central and western forms according to H. W. Parker (1940). An additional species, *Neobatrachus sutor*, is known from Western Australia.

ous populations to one another can be established. The type locality is "near Adelaide" in South Australia.

NEW SOUTH WALES RECORDS

In New South Wales, *Neobatrachus pictus* has been recorded only from west of the Dividing Range. I have taken it as far east as Mt. Stromlo, Australian Capital Territory, which is 20 miles west of the main divide, so it is conceivable that more intensive collecting will result in a few records on the Dividing Range or to the east.

The Australian Museum has specimens from:

Nyngan (Nos. 13669-13671)
Darling River (Nos. 5178-5180)
Guntawang (No. 7483)
Warialda (No. 7451)

Literature records for localities other than those given above are Rylstone (Fletcher, 1890) and Urana (Fletcher, 1891a).

AUSTRALIAN CAPITAL TERRITORY RECORDS

The American Museum of Natural History has specimens from:

Mt. Stromlo (Nos. 59112-59114)

VICTORIA RECORDS

Literature records are as follows: Melbourne and Sandhurst (H. W. Parker, 1940); Sandhurst and Parwan (Lucas, 1892). (Sandhurst is an old name for Bendigo.)

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Birdsville (Nos. 13964, 13965)
Warwick (No. 5511; the cotype of *Heleioporus sudelli* Lamb, 1911).

SOUTH AUSTRALIA RECORDS

The Australian Museum has a specimen from:

Naracoorte (No. 5966)

Waite (1929) records this species from Reynella (20 miles south of Adelaide).

COMMENTS

The Australian Museum has a cotype of Lamb's (1911) *Heleioporus sudelli* (No. 5511). It is badly faded and in very poor condition.

The body length is 41.4 mm. and the tibia 12.5 mm. The tibia length/body length ratio, therefore, is 0.30. The metatarsal tubercle is white, but so is the rest of the specimen. The finger length sequence is $3 > 1 > 2 > 4$. The vomerine teeth are between the choanae, a fact that disposes of H. W. Parker's (1940) suggestion that Lamb's species was "Possibly based on a specimen of *Limnodynastes* sp."

This cotype of *Heleioporus sudelli* is identical with *Neobatrachus pictus* in all but the color of the tubercle, as was noted by Fry (1912, p. 106). Nieden (1923) and Loveridge (1935) suggest that *Heleioporus sudelli* is the same as *Heleioporus* (now *Neobatrachus*) *pictus*. However, Loveridge makes *Heleioporus pictus* a synonym of *Heleioporus eyrei* but, according to H. W. Parker (1940), Loveridge's *Heleioporus eyrei* is actually *Heleioporus pelobatoides*.

I agree with Nieden and Loveridge that *Heleioporus sudelli* should be regarded as synonymous with *Heleioporus* (now *Neobatrachus*) *pictus* until better data are offered to show that they differ. Hosmer (1958) has examined the type of *Heleioporus sudelli* and concurs.

Throughout Australia there are small species of *Neobatrachus* of the *pictus* type that are characterized by a black or dark brown inner metatarsal tubercle, peculiar webbing of the feet, pointed toes, diffuse nuptial pads in the males, and dark blotches on the upper parts. H. W. Parker (1940), using the generic name *Heleioporus*, divides this assemblage into four species and states that *Heleioporus pictus* is found in "New South Wales, west of the dividing range; Victoria; S. Australia in the south and east; ? S. Queensland; possibly also in eastern districts of West Australia." *Heleioporus centralis* occupies the dry center and northwest. *Heleioporus wilsmorei* is recorded from "The eastern parts of West Australia, east of the Darling Range." Finally, *Heleioporus pelobatoides* is the species of "the wetter south-western parts of West Australia." Main (1957b) has added a fifth species, *Neobatrachus sutor*, from south-west Australia. The differences among these forms are slight and perhaps of the same magnitude that one would expect in intraspecific variation. The fact that Parker's four species appear to replace one another geographically,

and differ from one another only slightly, might suggest that we are dealing with subspecies. This seems most unlikely, however, as Main (1957b) found *Neobatrachus sutor*, *Neobatrachus centralis*, *Neobatrachus wilsmorei*, and *Neobatrachus pelobatoides* to be sympatric at Morawa, Western Australia.

LITERATURE

This form was first described as *Neobatrachus pictus* by Peters (1863). He thought his new species was sufficiently different from the species of *Heleioporus* described up to that time (*albopunctatus* and *eyrei*) to be put in a separate genus. In this connection it is of interest to note H. W. Parker's (1940) suggestion that, if a division of the genus *Heleioporus* is possible or desirable, *albopunctatus*, *australiacus*, and *eyrei* [to which we should now add Lee and Main's (1954) *psammophilus* and *inornatus*] should remain as *Heleioporus*, and *pictus*, *centralis*, *wilsmorei*, and *pelobatoides* should be placed in the genus *Neobatrachus*. Main (1957b) has taken this step and revived *Neobatrachus*, adding *sutor* as a new species.

General descriptions, using the name *Heleioporus pictus*, are given by Boulenger (1882), Fletcher (1891a), Lucas and Le Souëf (1909), Lamb (1911, as *Heleioporus sudelli*), Richard Deckert (1915), Nieden (1923, with drawings based on Spencer, 1896b, of the foot, tadpole, and tadpole mouth; Spencer's drawings are of the central Australian form that H. W. Parker, 1940, named *Heleioporus centralis*), Waite (1929, with drawings of the plate, hand, foot, and teeth), and H. W. Parker (1940). Main, Lee, and Littlejohn (1958) discuss the pattern of distribution.

Brief mention is made by Krefft (1865, as *Neobatrachus fictus*), Keferstein (1868a), Littlejohn and Main (1959), and, using the name *Heleioporus pictus*, by Fletcher (1890, 1894b, 1898), Lucas (1892, 1897), Fry (1914, with a ventral view of the sternal apparatus and dorsal and lateral views of the terminal phalanx of the fourth toe), and Barrett (1943).

Hosmer (1958) studied the type of *Heleioporus sudelli* in the Queensland Museum.

Sweet (1908) described the nephrostomes and vasa efferentia; Procter (1921), the pec-

toral girdle; Oliver (1909), the truncus arteriosus; and Nicholls (1916), the vertebrae. All used the name *Heleioporus pictus*.

Notes on the central Australian and Western Australian form related to *Neobatrachus pictus* can be found in Spencer (1896b, with a color plate of the adult and figures of the tadpole and feet), Spencer and Gillen (1912, with the color plate from Spencer, 1896b), Andersson (1913a), Werner (1914), Nieden (1923), Buxton (1923), Waite (1929), Love-ridge (1935), H. W. Parker (1940), Glauert (1945), Kinghorn (1945), Main (1954a and 1957b), Bentley, Lee, and Main (1958), Main, Lee, and Littlejohn (1958), Littlejohn and Main (1959), and Main, Littlejohn, and Lee (1959).

Limnodynastes dorsalis (Gray)

THE SAND FROG

Plate 35, figures 3, 4; text figures 13, 14

DIAGNOSIS

Limnodynastes dorsalis can be distinguished from all other species in eastern New South Wales by the presence of a large oval gland on the tibial section of the leg or by the yellow skin ridge that extends from below the eye to the base of the arm.

DESCRIPTION

This is a stout-bodied species with a rounded snout, these features giving it a "toad-like" appearance. It shows considerable geographic variation in color pattern, but throughout eastern New South Wales it is nearly uniform. The following description is based on individuals from this area. In H. W. Parker's (1940) terminology these individuals are *Limnodynastes dorsalis grayi*.

The color of the back and dorsal part of the appendages varies from grayish to dark olive-green. In many specimens there are numerous small black spots on the back, but these are so inconspicuous that the general effect is one of uniform coloration. The posterior surface of the thigh is black, with numerous tiny silver-gray spots. There are a prominent yellow wart on each side of the cloaca and a conspicuous yellow ridge extending from below the eye to the base of the arm. This ridge widens out into a bulb at its posterior end. The iris is golden.

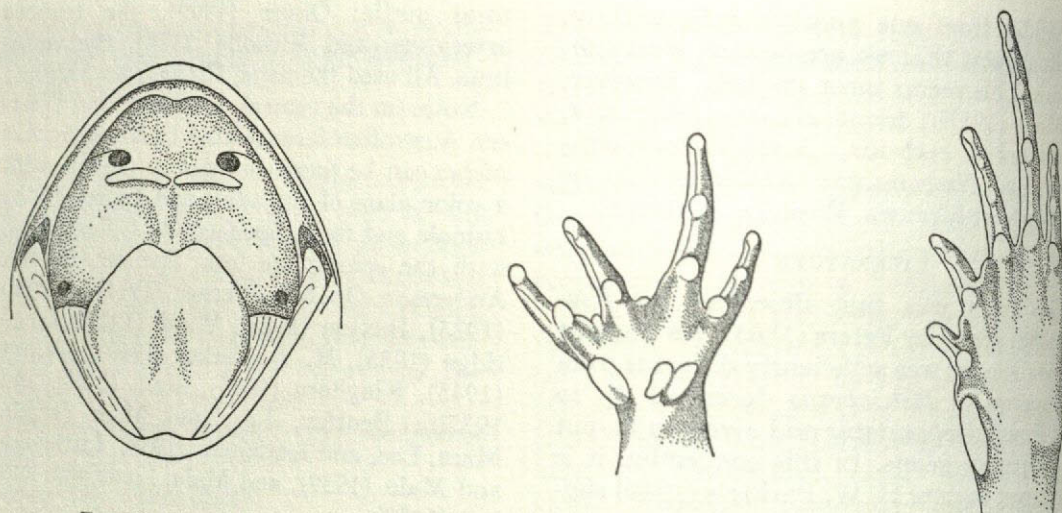


FIG. 13. *Limnodynastes dorsalis*. Open mouth, hand, and foot. A.M.N.H. No. 59115. Booroolong Creek, near Armidale, New South Wales.

The sides are white or yellowish and mottled with back.

The under parts vary from nearly clear white or yellowish to mottled with purplish brown. The throat of the male is yellowish. The ventral surface of the legs is purplish brown, with tiny white spots.

There are numerous small warts on the dorsal surface. The ventral surface is smooth.

Limnodynastes dorsalis is a widespread species, and many areas have populations with distinctive color patterns. In south-central New South Wales and in Victoria the individuals are strikingly colored. In Parker's terminology they are *Limnodynastes dorsalis dumerili*. One is shown in plate 35, figure 4. When alive this male had a pale golden midline stripe that extended from the eye to the cloaca. The background color of the upper parts was a dark golden color, and in addition there were numerous large, dark, greenish brown stripes and spots. There was a dark stripe on each side of the midline, as in *Limnodynastes peroni*. The sides were blue-gray, with a dark reticulum, and the ventral side was white, with a dark reticulum. The throat had a yellow wash. There was a yellowish glandular spot on each side of the

Limnodynastes dorsalis is a short-legged and stocky species. The Australian Museum has a series of nine adults (Nos. 10650-10658) from the Yanco Agricultural School

on the Murrumbidgee River. Six males range in length from 66.9 to 86.6 mm. The longest of these is the largest specimen that I have seen. Three females vary from 76.6 to 83.1 mm. In eastern New South Wales most of the adults are from 50 to 65 mm. in body length.

The American Museum of Natural History has 21 adult specimens from eastern Australia. These vary in body length from 50.0 to 68.5 mm. The mean tibia length/body length ratio is 0.38 ± 0.01 (0.36-0.41). The mean head width/head length ratio is 1.21 ± 0.04 (1.13-1.33). The mean head length/body length ratio is 0.36 ± 0.02 (0.32-0.40). The mean tibia length/body length ratio for the Yanco specimens mentioned above is 0.37 ± 0.01 (0.36-0.38).

It might be mentioned that the large glandular ridge that extends across the jaw articulation makes accurate measurements of head length and head width difficult. As a consequence there is considerable variation in the ratios involving these head measurements.

The tympanic membrane is oval, with the long axis vertical.

The fingers are not webbed (fig. 13). The third finger is the longest, and the others are of nearly equal length. The usual length sequence is $3 > 2 > 1 = 4$. There are three metacarpal tubercles, one inner and two outer. The second finger of the female has a flange on the inner border. The male has

nuptial pads on the dorsal side of the first two fingers. These slight elevations, which are brownish in color, have a surface resembling fine sandpaper.

The toes have a rudimentary web (fig. 13). There is a well-developed and shovel-shaped inner metatarsal tubercle but no outer metatarsal tubercle.

The tongue is broad. The vomerine teeth are in two transverse series behind the choanae. They meet at the midline and extend laterally as far as the middle or the outer edge of the choanae (fig. 13).

HABITAT

This species, as are so many found in Australia, is a burrowing form. I have never seen it active during the day. After dark it may be found hopping along the ground far from water while searching for food. Adults were collected along the edge of a small pond (pl. 29, fig. 1) and near a creek (pl. 28, fig. 2). It can be seen from the distribution map (fig. 14) that *Limnodynastes dorsalis* is found in areas that differ greatly in climate and habitat.

VOICE

Unknown. Several authors have referred to the call, but none has described it with exactness.

BREEDING HABITS

Fletcher (1889) described the egg mass as being of the frothy and floating type. In this respect *Limnodynastes dorsalis* resembles *L. peroni* and *L. tasmaniensis*. He observed a clasping pair near Sydney in November and eggs in October (Fletcher, 1894b) and February. The breeding season, therefore, extends from spring to late summer. He observed tadpoles as early as September and as late as June. The tadpoles reached a length of 75 mm., and the young were 21 mm. after metamorphosis.

Other references to breeding habits appear to be based on these observations by Fletcher. English (1910) has some observations that may pertain to this species.

EMBRYONIC DEVELOPMENT

Nothing is known of early development. Fletcher (1889) mentions that the ova are

small and that the larvae hatch at a comparatively early stage.

Six tadpoles of this species were collected on February 23, 1953, near Saw Pit Creek, 6 miles east of Hotel Kosciusko, New South Wales. In four of these the front legs were already out and in the other two almost so. The last two, which were 66 and 68 mm. in total length, are described here.

The dorsal surface is a uniform olive-brown, except for the region anterior to the eyes which is more transparent. The myotome section of the tail has black spots. The ventral skin has a complete layer of golden chromatophores which, to the eye, give the skin a whitish appearance.

The anus is median. There are two complete and four incomplete rows of horny teeth on the upper jaw and one complete, one incomplete, and one complete row on the lower jaw.

GEOGRAPHIC DISTRIBUTION

Limnodynastes dorsalis is found in eastern Australia from Cape York to Adelaide and Tasmania (fig. 14). In Western Australia it is recorded from the Chapman River in the north to the southwest corner of the state. There are no records of its occurrence in the central portion of the continent. The type locality is Western Australia.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Tenterfield (Nos. 13123, 13124)
Inverell, at 1953 feet (No. 7509)
Nambucca River (Nos. 5878-5880)
Warrell Creek, Nambucca River (Nos. 4235, 4627)
Gurravambi, Nambucca River (Nos. 6292-6296)
Nyngan (Nos. 11770-11773, 12058-12060)
Cassilis (Nos. 7448-7450)
Guntawong, Mudgee (No. 7367)
Wyong (No. 11071)
Avoca (No. 8503)
Orange (No. 9421)
Tarana (Nos. 3196, 3197)
Honeysuckle Falls, Fish River, Tarana (Nos. 3118-3120)
Hampton District (No. 13383)
Mt. Victoria (Nos. 7322-7324)
Katoomba (Nos. 5203-5209)
Randwick (Nos. 1426, 5004, 5089, 5262, 5263, 5366-5370, 5432-5434, 5516-5519)



FIG. 14. *Limnodynastes dorsalis*. Geographic distribution.

Maroubra (Nos. 4226, 4227)
 Sydney (No. 6795)
 Coogee (No. 8693)
 Gouldburn (No. 2398)
 Yass (No. 7399)
 Berridale (Nos. 5231, 5232)
 Snowy River at Jindabyne (No. 5421)
 Mt. Kosciusko (No. 989)
 Albury (No. 13420)
 Yandenbak, Riverina (Nos. 975, 976)
 Mersol Creek, Riverina (No. 5869)
 Mulwala, Murray River (Nos. 7319-7321)
 Leeton (No. 9615)
 Yanco Agricultural High School (Nos. 10650-10660)

The American Museum of Natural History has specimens from:

Booroolong Creek, near Armidale (Nos. 59115-59117)
 Ebor (No. 59120)
 Capertee (Nos. 59125-59127)
 Forbes (Nos. 23910, 23911)
 Megalong Valley, Katoomba (Nos. 13130, 13131)
 Burradoo (Nos. 59118, 59119)
 Saw Pit Creek, 6 miles east of Hotel Kosciusko at 3930 feet (Nos. 59121-59124)
 Albury (Nos. 59128, 59129)

Localities mentioned in the literature that are not essentially the same as those listed

above are: Keera, 15 miles southeast of Bingara (Slevin, 1955), Clarence River near Rylston and Swan Hill on the lower Murray (Krefft, 1863), Tamworth, Bathurst, Jervis Bay (Fletcher, 1894b), Nowra (H. W. Parker, 1940), Cootamundra (Loveridge, 1935), Cooma (Fletcher, 1892), and Port Stephens (Fry, 1913a).

Fletcher's (1891a) record from Emu Plains is an error due to misidentification, if the record is based on the four specimens from this locality labeled *Limnodynastes dorsalis* that he deposited in the Australian Museum. Three are *Limnodynastes tasmaniensis*, and one is *Limnodynastes fletcheri*.

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Somerset, Cape York (Nos. 4525, 4526)
Eidsvold, Burnett River (Nos. 5771-5791, 5807-5815, 5909, 5910, 7948)
Moola (Nos. 11697, 11698)
Brisbane (Nos. 4380, 4695, 5959)

The American Museum of Natural History has a specimen from:

Somerset, Cape York (No. 54224)

Queensland localities mentioned in the literature that are not essentially the same as those listed above are: Cooktown (Loveridge, 1935), Atherton (Andersson, 1916), Torrens Creek, MacKay, Gayndah, and near Cooktown (H. W. Parker, 1940), and Koolong, 25 miles north of Gin Gin, and Coomooboolaroo, 15 miles south of Duaringa (Slevin, 1955).

NORTHERN TERRITORY RECORDS

The British Museum has some old specimens that Boulenger (1882) listed from Port Essington, but H. W. Parker (1940) questions the locality. This is the only record known to me of the occurrence of *Limnodynastes dorsalis* in the Northern Territory, and if it is in doubt we must await additional specimens to establish its presence. Parker's "?" may itself be in error. Günther (1858) and Boulenger (1882) list the specimens with an asterisk after the locality. This asterisk refers to a footnote describing the contents of the stomach. Perhaps the asterisk evolved into a question mark over the years. But see

also the doubts of Glauert (1947) regarding the locality.

VICTORIA RECORDS

The Australian Museum has specimens from:

Warragul (Nos. 7553-7555)

The American Museum of Natural History has specimens from:

Kiewa River Flats (Nos. 5908-5910, 5913)
Gunbower (Nos. 59130, 59131)
5 miles east of Cann River (No. 59132)
Melbourne (Nos. 50227, 50228)

Victoria localities mentioned in the literature that are not essentially the same as those already listed are: Little River (Brazenor, 1947), Prahan to Mordialloc (Lucas, 1892), Benalla (Fletcher, 1891a), and Lake Boga (Krefft, 1862).

TASMANIA RECORDS

The Australian Museum has specimens from:

Launceston (Nos. 6037-6040)
Port Sorel (No. 7471)
Ulverstone (Nos. 7593, 7594)
Eaglehawk Neck (Nos. 7827, 7828)
Flinders Island (Nos. 6072, 7073)

An additional locality mentioned in the literature is Stanley (Loveridge, 1935), but this is based on a specimen of *Limnodynastes peroni*.

SOUTH AUSTRALIA RECORDS

The Australian Museum has a specimen from:

Kingscote, Kangaroo Island (No. 7135)

The American Museum of Natural History has a specimen from:

Adelaide (No. 23590, a cotype of *Limnodynastes dumerilii*)

Other localities mentioned in the literature are: Mt. Mary Range (Boehm, 1943) and Naracoorte (Fry, 1913a).

WESTERN AUSTRALIA RECORDS

The Australian Museum has specimens from:

Perth (Nos. 2992-2994, 7586)
Cranbrook (No. 7702)
Tambellup (No. 9958)

The American Museum of Natural History has specimens from:

Scaddan (No. 46059)
 Tambellup (No. 46056)
 Welshpool (Nos. 46057, 46058)
 Perth (No. 59133)

Other localities mentioned in the literature are: Geraldton (Fletcher, 1898), Balcatta Beach, Nornalup, and Point Peron (Loveridge, 1935), Houtman's Abrolhos, Chapman River, and Mt. Toolbrunup (H. W. Parker, 1940) and Eradu, Subiaco, Buckland Hill, Fremantle, Harvey, Bunbury, Boyanup, Gooseberry Hill, and Albany (Werner, 1914).

GEOGRAPHIC VARIETIES

Fry (1913a) was the first to study geographic variation in this species. He recognized three subspecies. *Limnodynastes dorsalis* was restricted to the coastal areas of Western Australia (except the coast of the Great Australian Bight) and to the Northern Territory. *Limnodynastes dorsalis dumerilii* was restricted to the coastal areas of Queensland, to eastern New South Wales, Victoria, southeastern South Australia, and Tasmania. *Limnodynastes dorsalis interioris* was restricted to the Riverina district of New South Wales. Later Fry (1915) split *L. d. dumerilii* and recognized as new *L. d. terrae-reginae* as the form occurring in Queensland north of the Burnett River Basin.

H. W. Parker (1940) had a somewhat different suggestion for the recognition of subspecies in *Limnodynastes dorsalis*. *Limnodynastes dorsalis dorsalis* and *L. d. terrae-reginae*, as recognized by Fry, were retained. Fry's *L. d. interioris* was recombined with *L. d. dumerilii*. On the other hand, two new subspecies were recognized: individuals from New South Wales east of the Dividing Range and southeast Queensland (?) were named *L. d. grayi*; the name *L. d. insularia* was given to individuals from Tasmania.

According to the classification of H. W. Parker (1940), my description given at the beginning of the account of this species, together with the individual shown in plate 35, figure 3, applies to *L. d. grayi*. The individual shown in plate 35, figure 4, and also described in the text is *L. d. dumerilii*. The drab-colored individuals occur east of the Dividing Range

in New South Wales. The more strikingly patterned individuals occur west of the Dividing Range in New South Wales and in Victoria.

Personally I do not think much is to be gained by recognizing subspecies in *Limnodynastes dorsalis* at this stage of our knowledge of the species. I have seen enough material to be convinced that the species is highly variable and that on the basis of the "75 per cent rule" one could recognize many more subspecies than either Fry or Parker has done. Some of the subspecies will probably be found to be valid species, but until evidence on this point is forthcoming, there will be less confusion if we lump all varieties and recognize only *Limnodynastes dorsalis*.

LITERATURE

The frog now regarded as *Limnodynastes dorsalis* has been described as a new species on four separate occasions, a perhaps not surprising situation in the case of a variable and widely distributed form.

Gray (1841a, 1841b) originally named it *Cystignathus dorsalis*. In 1845 he published a figure of the adult, foot, and hand. The type locality is Western Australia. The type specimen is in the British Museum (Natural History).

Peters (1863) next described individuals from Adelaide, South Australia, as *Limnodynastes (Platyplectron) dumerilii*.

Its third emergence was as *Heliorana grayi* (Steindachner, "1869" [1867]). Steindachner's specimen was from New South Wales, and the description included a fine figure of the adult, mouth, hand, and foot.

The fourth description was as *Platyplectron superciliare* (Keferstein, 1867). No locality other than "Australia" was given. The following year Keferstein (1868a) provided a figure of the adult, and he used the name *Heliorana superciliaris*. In addition, the species now recognized as *Limnodynastes dorsalis* was described or mentioned under the names *Limnodynastes dorsalis*, *Platyplectron dumerili*, *Heliorana grayi*, and *Heliorana superciliaris*.

Boulenger (1882) united all as *Limnodynastes dorsalis*, and no further changes were made until Fry (1913a, 1915) and Parker (1940) recognized subspecies.

General descriptions can be found in Günther (1858), McCoy (1880, with three color plates of the adult and drawings of the open mouth, hand, foot, and side of head), Boulenger (1882), Fletcher (1889, 1898), Lucas and Le Souëf (1909, with a reproduction of one of McCoy's figures), English (1910, with a color plate), Fry (1913a, with several illustrations of the varieties *dumerilii*, *typica*, and *interioris*; 1915, with a drawing of the sacrum), Richard Deckert (1915, with a color plate of the adult), Nieden (1923, with the adult and open mouth redrawn from Steindachner, "1869" [1867]), Waite (1929, with a photograph of the adult and drawings of the mouth, hand, foot, and teeth), Taylor (1935), H. W. Parker (1940, with a figure of the anterior cranial elements), Main (1954a), and Slevin (1955).

A description and drawing of the pectoral muscles are given by Fry (1917). Procter (1921) briefly mentions the scapula, and Sweet (1908) describes and figures some features of the urinogenital system. The truncus arteriosus is described by Oliver (1909); the brain, by Abbie and Adey (1950); and the vertebrae, by Nicholls (1916).

References that consist primarily of geographical data are: Krefft (1862, 1863, 1965, 1867), Fletcher (1890, 1891a, 1892, 1894b, 1898), Lucas (1892, 1897), Roth (1908), Andersson (1913a, 1916), Werner (1914), Kinghorn (1924), Loveridge (1934, 1935), Boehm (1943), and Brazenor (1947).

Limnodynastes dorsalis is mentioned, but with little or no new information of importance given, by: Girard (1853), who suggested it be placed in the new genus *Wagleria*, McCoy (1867), Cope (1865 and 1867, pointing out that *Heliorana grayi* is the same as *Platyplectrum dumerilii*), Günther (1867, 1868a, 1868b, as *Limnodynastes dumerilii*), Steindachner (1868), Krefft (1870), Günther (1876), who suggested that *Limnodynastes dorsalis*, *Limnodynastes* (*Platyplectrum*) *dumerilii*, *Platyplectrum superciliare*, and *Heliorana superciliaris* were one and the same and that the genus name should be *Platyplectrum*, Boettger (1892), Aflalo (1896), Fraser (1903), Johnston (1912), Fry (1914), Harrison (1921, 1922), Alexander (1922), Lord and Scott (1924), Waite (1925, 1927), Glauert (1929, 1945), Noble (1931), Scott

(1942), Barrett (1943), Kinghorn (1944), and Moore (1957a).

Limnodynastes ornatus (Gray)

THE ORNATE BURROWING FROG

Plate 36, figure 1; text figures 15, 16

DIAGNOSIS

A combination of these features distinguishes *Limnodynastes ornatus* from all other species in eastern New South Wales: vomerine teeth behind choanae, inner metatarsal tubercle shovel-shaped, no tibial gland, no light spots lateral to the cloacal opening (as in *Limnodynastes dorsalis*), no glandular ridge from eye to arm (as in *Limnodynastes dorsalis*).

Some difficulty may be encountered in distinguishing *Limnodynastes ornatus* from juvenile specimens of *Limnodynastes dorsalis*, which may not have well-developed tibial glands. The presence in *Limnodynastes dorsalis* of the glandular ridge below the eye, and spots lateral to the cloaca, coupled with the absence of these structures in *Limnodynastes ornatus*, will allow separation.

DESCRIPTION

I did not collect *Limnodynastes ornatus* in New South Wales. The only living individuals observed were at Rainsby Station near Aramac, Queensland. These were estivating animals secured by digging in the sand of a dry creek bed (pl. 31, fig. 1). When first observed, the color of the dorsal surface was pale and closely resembled the sand. A few hours later the animals were considerably darker, the background color of the dorsum was light brown, and there were numerous irregular dark brown blotches. The central region of the snout, bounded laterally by the eyes and nostrils, was light brown. There was a large, shield-shaped patch on the back just posterior to the eyes. One individual in a total of 12 had a broad, pale, midline stripe. The arms were reddish brown, with dark brown bars. The legs were similar. The under parts were white except for the legs which had a pink cast.

There are numerous shallow warts on the dorsal surface. The ventral surface is smooth.

This is a medium-sized and moderately stout frog. The largest individual that I have

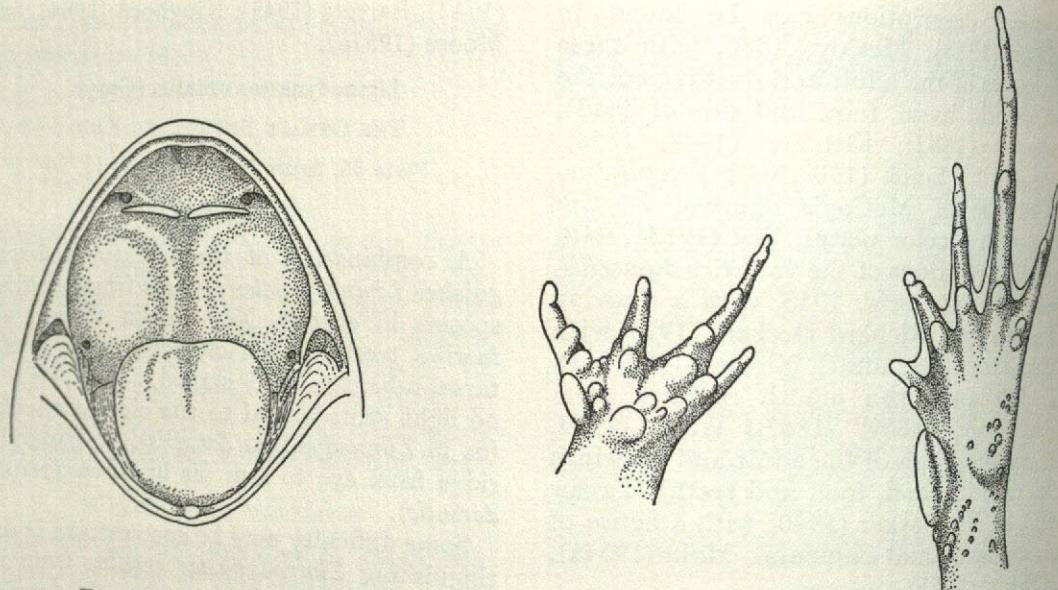


FIG. 15. *Limnodynastes ornatus*. Open mouth, hand, and foot. A.M.N.H. No. 59515. Rainsby Station, near Aramac, Queensland.

seen is a female 44 mm. in body length taken near St. George, Queensland (A.M.N.H. No. 59511). The body proportions of four specimens from Rainsby Station (near Aramac, Queensland) and one from near St. George, Queensland, the body lengths of which range from 34.1 to 43.7 mm., are: tibia length/body length, 0.43 ± 0.01 (0.41–0.44); head width/head length, 1.22 ± 0.02 (1.19–1.25); head length/body length, 0.32 ± 0.01 (0.30–0.34).

The pupil is oval, with the long axis horizontal. The iris is dark bronze.

The tympanic membrane is indistinct.

The fingers are not webbed (fig. 15). The length sequence is $3 > 1 = 2 > 4$.

The toes are slightly webbed, the web extending only to the fourth joint from the tip of the fourth toe (fig. 15). The inner metatarsal tubercle is well developed and shovel-shaped.

The tongue is broad (fig. 15). The choanae are widely separated. The vomerine teeth are posterior to the choanae and in two elongate series that extend from near the midline outward as far as the lateral edges of the choanae.

HABITAT

Limnodynastes ornatus occurs in a variety of habitats. In New South Wales it is found mainly in the dry areas west of the Dividing

Range, but it reaches the coastal zone along the Clarence River, which has an annual rainfall of 40 to 50 inches. In Queensland, Andersson (1916) records it from Cedar Creek, which is within the limits of the rain forests, and there are many records from localities along the coast with abundant rainfall. In addition there are records for localities in the arid zones of Queensland, the Northern Territory, and Western Australia.

Clearly this is a versatile species, and a fascinating study could be made of its comparative biology in the diversity of habitats in which it occurs.

Nearly all our information on the natural history of this species comes from Spencer (1896b). His observations were made in central Australia on individuals that H. W. Parker (1940) now regards as a different species, namely, *Limnodynastes spenceri*. On the basis of morphological data alone, I would question this splitting. In any event the two are very similar in appearance and probably in habits as well.

Spencer found them in fair numbers around water holes and described their habits as follows: "In the adult form it is always found in relatively soft, sandy ground, most generally in the beds of creeks which are dried up, but in which, after digging down for a short depth, the sand is more or less damp

"It does not make a permanent burrow, but appears to come to the surface in the cool of the night and to remain hidden in the sand perhaps a foot or more underground during the daytime. Its tracks can often be traced over the sand to a spot at which they disappear, and by digging down here the animal is usually to be found. It does not appear to store up water and aestivate as does *C. platycephalus*, and it feeds upon beetles, many of which are to be found in its stomach.

"When placed on the sand it immediately begins to burrow, moving its hind legs downward and slightly outwards, so as to make a way for its body, and it disappears from sight in a very short time. Under these conditions, as a means of moving the soft sand aside, the use of its strong web and metatarsal tubercle is easily seen."

Slevin (1955) found individuals "... at the water's edge of a shallow, muddy lagoon."

As mentioned above, I observed *Limnodynastes ornatus* only at Rainsby Station near Aramac, Queensland. Here in mid-June the individuals were estivating in the sandy bed of a creek that was nearly dry (pl. 31, fig. 1). They were between 12 and 16 inches below the surface, where the sand was slightly moist to the touch.

BREEDING HABITS

There are almost no data on breeding habits and none on voice. In the drier parts of the species' range, breeding takes place after heavy rains.

Boulenger (1882) noted that "The female has on the breast two cicatrices which are evidently caused by the thumbs of the male; this proves that the male seizes the female under the axillae, and not round the waist. . . ." Slevin (1955) found that the male "... has the third finger of each hand greatly flattened and the bone protruding from the tip" and reasons that it is this digit and not the thumb that is modified for holding the female.

EMBRYONIC STAGES

The early stages are unknown. Spencer (1896b) described tadpoles from central Australia (*Limnodynastes spenceri* of H. W. Parker, 1940).

GEOGRAPHIC DISTRIBUTION

Limnodynastes ornatus is widely distributed in Australia (fig. 16). In eastern Australia it ranges from Thursday Island off Cape York south to Guntawang in New South Wales. The type locality is Port Essington on the Cobourg Peninsula of the Northern Territory. There are no records for Victoria, Tasmania, or the southern portion of South Australia.

H. W. Parker (1940) believes that the populations in central Australia are a different species, *Limnodynastes spenceri* (triangles in fig. 16). Main and Calaby (1957) report that individuals from Abydos Station (near the De Gray River) in Western Australia conform to Parker's description of *Limnodynastes spenceri*. All these records for *Limnodynastes spenceri* are for localities with an average yearly rainfall of less than 10 inches. *Limnodynastes ornatus* and *Limnodynastes spenceri* are so much alike that I have not regarded them as different species.

Keferstein (1868a) lists Sydney as a locality for this species. It has not been recorded subsequently, so it would seem probable that his report is in error.

The paucity of dots on the distribution map (fig. 16) is due to the fact that only a single specimen of this species in the Australian Museum was examined.

NEW SOUTH WALES RECORDS

This is an inland species that reaches the coast in the northeast part of the state. It has been recorded from: Jaffa, Ashford Downs (Australian Museum No. 9411); Warialda (Fletcher, 1894b); 40 miles south of Moree (H. W. Parker, 1940); the Clarence River (Krefft, 1865; Keferstein, 1868a; Fletcher, 1894b; H. W. Parker, 1940); and Guntawang (Fletcher, 1890; H. W. Parker, 1940).

QUEENSLAND RECORDS

The American Museum of Natural History has specimens from:

Red Island Point, Cape York (Nos. 54245, 54246)
Newcastle Bay, near Somerset (Nos. 54211, 54212)

Brown's Creek, near Tozer Gap, Cape York
(Nos. 54256, 54267)

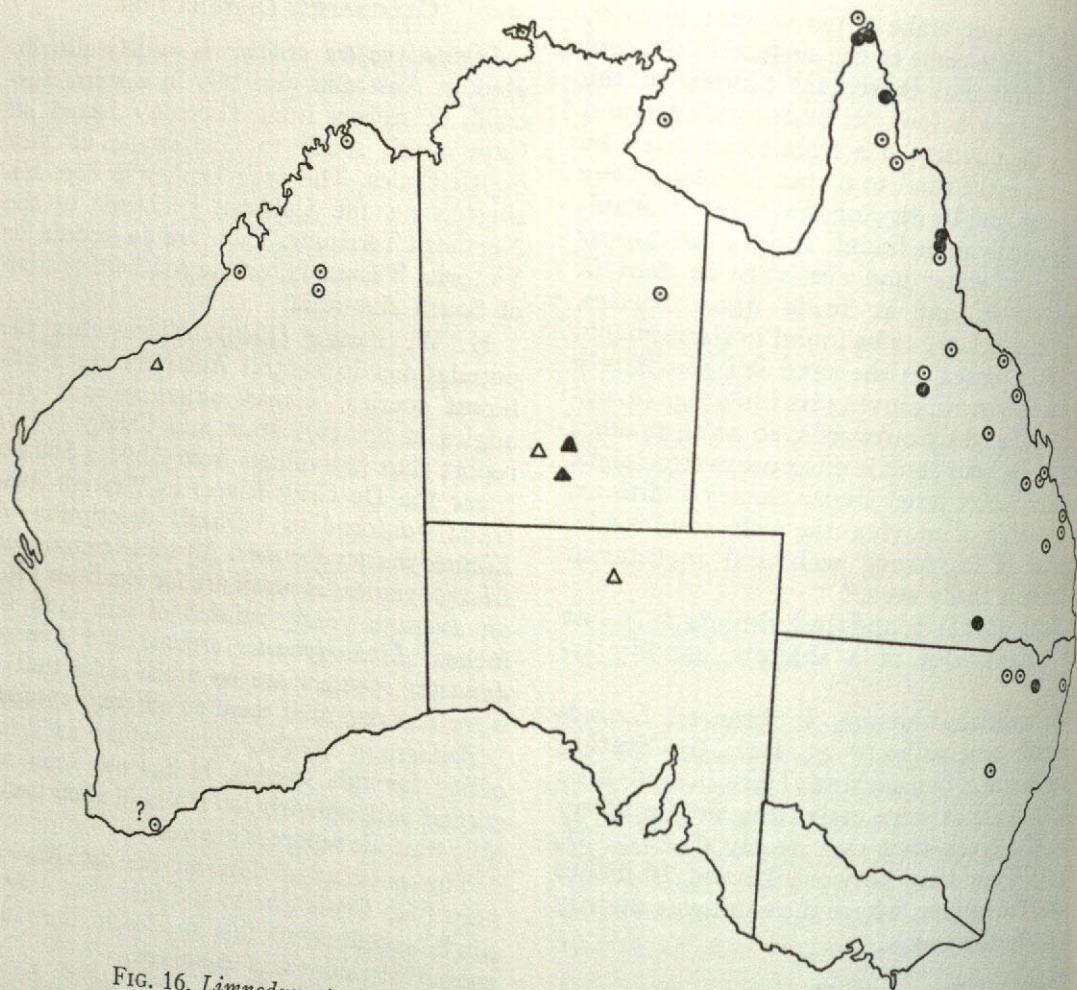


FIG. 16. *Limnodynastes ornatus*. Geographic distribution. The triangles are for records of *Limnodynastes spenceri*, a species of doubtful validity.

Barron River, north of Cairns (Nos. 54179, 54180)
 Speewah, near Cairns (No. 54194)
 Rainsby Station, near Aramac (Nos. 59512-59515)
 10 miles southwest of St. George (No. 59511)

Additional localities reported in the literature are: Coen, Mundubbera, and Rutherford on the Sellheim River (Loveridge, 1935); Stewart River, Port Denison, Peak Downs, Mackay, Torrens Creek, Westwood, and Rockhampton (H. W. Parker, 1940); Coomoboolaroo and Kolonga (Slevin, 1955); Thursday Island and Burnett River district (Boettger, 1894); and Cedar Creek in the rain forest zone of the Atherton-Herberton Tableland (Andersson, 1916).

NORTHERN TERRITORY RECORDS

H. W. Parker (1940) lists specimens of *Limnodynastes ornatus* from Alexandria Sta-

tion, Port Essington, and Groote Eylandt. Mitchell (1955) gives Central Hill, Umba Kumba, and Port Langdon in Groote Eylandt as localities.

The American Museum of Natural History has specimens from central Australia that would be called *Limnodynastes spenceri* by H. W. Parker (1940). They are as follows:

Alice Springs (Nos. 409-414)
 Central Australia (Nos. 724, 725)
 Finke River (Nos. 23763, 23764)

H. W. Parker (1940) gives an additional locality, namely, Hermannsburg, for *Limnodynastes spenceri*.

SOUTH AUSTRALIA RECORDS

Spencer (1896b) mentions that he obtained tadpoles of *Limnodynastes ornatus* from water holes between Oodnadatta and Charlotte

Waters. According to H. W. Parker's (1940) terminology these would be *Limnodynastes spenceri*.

WESTERN AUSTRALIA RECORDS

Most of the records are for the northern half of the state. Fletcher (1898) had material from the junction of the Fitzroy River and Margaret Creek. Andersson (1913a) gives these localities: Fitzroy River in the interior of the Kimberley Division; St. George Range, Kimberley Division; and Streets Station near Broome, Dampier Land. Fry (1914) lists Napier Broome Bay. H. W. Parker (1940) mentioned a specimen from Albany, and this appears to be the only record of the occurrence of *Limnodynastes ornatus* in the southern part of the state. A. R. Main (personal communication), who has made a special study of the Western Australian frogs, has never observed this species in the southern part of the state.

According to Main and Calaby (1957) specimens from Abydos Station (near the De Gray River) agree with H. W. Parker's (1940) description of *Limnodynastes spenceri*.

LITERATURE

This species was first described as *Discoglossus ornatus* by Gray (1842) on the basis of material from Port Essington. The type is in the British Museum (Natural History). In 1845 Gray published illustrations of the adult, hand, and foot, and in the captions used the original name, but in the text used *Perialia ? ornata*.

Günther (1863a) described this species as *Platyplectrum marmoratum* on the basis of material from the Clarence River in New South Wales. The type is in the British Museum (Natural History).

Cope (1866) gave the name *Platyplectrum occidentale* to a specimen from Western Australia.

Steindachner ("1869" [1867]) described a New South Wales specimen as *Opisthodon frauenfeldi*.

In Boulenger's "Catalogue" (1882) all are united as *Limnodynastes ornatus*. There was no further change until H. W. Parker (1940) separated the central Australian form as *Limnodynastes spenceri*.

In addition, descriptions are given by Günther (1858), Keferstein (1867 and 1868a,

as *Platyplectrum marmoratum* and *Platyplectrum ornatum*), Spencer (1896a; this description would apply to Parker's *Limnodynastes spenceri*, as does that of Spencer and Gillen, 1912), Lucas and Le Souëf (1909), Andersson (1913a), Nieden (1923), Waite (1929; the description applies to Parker's *Limnodynastes spenceri*), H. W. Parker (1940), and Slevin (1955).

The scapula is described by Procter (1921), and the vertebrae are described by Nicholls (1916).

The following give little more than data on geographical distribution: Krefft (1865, as *Limnodynastes ornatus* and *Platyplectrum marmoratum*), Günther (1867), Fletcher (1890, 1894b, 1898), Boettger (1894), Roth (1908), Fry (1914), Andersson (1916), Loveridge (1935), and Mitchell (1955).

Minor mention is made by Krefft (1867), Steindachner (1868), Günther (1868a, 1868b, 1876), Fletcher (1889), Aflalo (1896), Buxton (1923), Kinghorn (1931), Loveridge (1938), and Glauert (1945).

It might be noted that Keferstein's (1868a) description of *Platyplectrum marmoratum* refers in the main to *Limnodynastes ornatus*, but the following quotation would seem to apply to *Adelotus brevis*: "Nach einer Mittheilung meines Freundes Krefft in Sydney das Männchen dieser Art zwei zahnartige Auswüchse am Unterkiefer und einen weit grösseren Kopf als das Weibchen."

Limnodynastes peroni (Duméril and Bibron)

THE BROWN FROG

Plate 36, figures 2-4; text figures 17, 18

DIAGNOSIS

Limnodynastes peroni can be distinguished from all other species in eastern New South Wales by the characteristic longitudinal dark and light stripes on the back, plus the greatly elongated first metacarpal.

DESCRIPTION

The back is covered with a series of longitudinal dark brown (or black) and light brown stripes. The most frequently encountered pattern is as follows: A narrow whitish band extends along the dorsal midline from the snout to the cloaca. On each side of it a dark brown (or black) band begins at the level of the nares, widens out at

the eyes, and then extends to the hind end of the body. The next more lateral bands are light brown. They begin as a single light area at the tip of the snout, divide at the level of the external nares, cross the top of the eye, and then extend to the posterior surface of the thighs. The next more lateral bands are dark. They begin immediately behind the eyes and extend to the posterior surface of the thighs. They are generally the outermost bands.

The sides are light brown, with dark brown spots, which may form a longitudinal series and, very rarely, definite bands. A dark band extends from the snout through the nares to the eyes and from the eyes through the tympanic membrane to the level of insertion of the arms. That portion of the upper jaw below this dark line is light brown, and there is usually a dark spot in this area anterior and ventral to the eyes. Posterior to the eyes, the dark band is bordered ventrally by a light-colored ridge that extends from the eyes to the point of insertion of the arms.

In a few specimens the median white stripe is missing or reduced. Such a pattern is the most frequent variation of the typical one.

The upper surfaces of the appendages are light brown, with dark brown (or black) spots or ill-defined cross bars.

The under surfaces are, for the most part, white, but the throat may have a grayish wash or even be heavily mottled with brown. In a few specimens this mottling extends over the chest, abdomen, and the appendages. The throat of the male may have a yellowish wash, the presence or absence of this feature presumably depending on the reproductive state of the individual.

Fletcher (1889) reports that "it is quite common to find the very young frogs with bright red or carmine longitudinal stripes on the back, corresponding with the light stripes of the adult, and also on the arms and legs. A spirit specimen 22 mm. from snout to vent still shows them well." I did not observe this in the few tadpoles that were raised in the laboratory to the juvenile stage.

This is a large frog that is *Rana*-like in general body form. The largest specimen that I collected is a male from Killara with a body length of 64 mm. The males are usually larger than the females (largest specimen 58

mm.) and have wider heads. The difference is often strikingly apparent when breeding pairs are observed and a large male is seen to be clasping a much smaller female. The smallest breeding female that was collected has a body length of 43 mm. The body proportions for 10 males (body length, 48.0–64.2 mm.) and 10 females (body length, 42.5–58.0 mm.) from eastern New South Wales are: tibia length/body length, males 0.47 ± 0.00 (0.45–0.49), females 0.46 ± 0.01 (0.42–0.49); head length/body length, males 0.33 ± 0.01 (0.30–0.38), females 0.32 ± 0.00 (0.29–0.34); head width/head length, males 1.06 ± 0.02 (0.97–1.21), females 1.00 ± 0.02 (0.95–1.08). The dimensions of the type, No. 4500 in the Muséum National d'Histoire Naturelle, Paris, are: body length, 57.7 mm.; tibia length, 26.4 mm.; head length, 18.3 mm.; head width, 18.5 mm.

The tongue is broad and has a slight posterior nick (fig. 17). The vomerine teeth are in two long and curved series that are very close, and in some specimens they nearly touch at the midline. They extend laterally well beyond the choanae.

The tympanic membrane is indistinct.

The fingers are not webbed (fig. 17). In the female the inner part of the second finger has a well-developed flange, a condition associated with the production of a foam type of egg mass. The inner edge of the first and the outer edge of the third fingers have less well-developed flanges. The arms of the breeding males are hypertrophied. In both the male and female of this species the first metacarpal is much elongated, noticeable externally because there is no joint at the base of the finger but only one near the tip where the metacarpal articulates with the first phalanx. In the male the sharp tip of the metacarpal may perforate the skin and project outward for as much as 1 mm. The bone thus forms a nuptial spine that aids the male in holding the female during amplexus. Breeding males, when collected, sometimes grasp the captor's hand with their arms. The captor is left with no doubt, then, as to the efficiency of the first metacarpal as a nuptial spine.

In some instances the whole thumb, or even the entire hand, of the male is much swollen and appears to be infected; the infection is

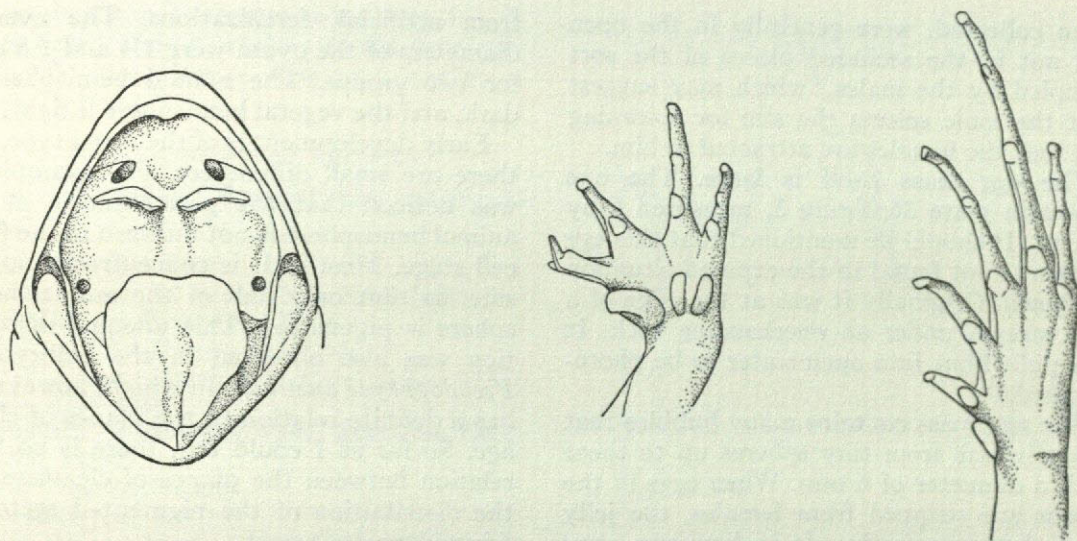


FIG. 17. *Limnodynastes peroni*. Open mouth, hand, and foot of a male.
A.M.N.H. No. 60541. Killara, New South Wales.

probably due to the entrance of bacteria through the opening made by the metacarpal. The first metacarpal of the female is elongated, as in the male, but I have not seen any individuals in which it perforates the skin.

There are one large inner and two medium-sized outer metacarpal tubercles (fig. 17). In some cases the two outer ones are so close to each other that they might be regarded as a single split metacarpal tubercle. The finger length sequence is $3 > 2 \geq 4 \geq 1$. The first, second, and fourth fingers are essentially equal in length.

The toes are not webbed. There is a single, rather small, flat, inner, metatarsal tubercle. There is no outer metatarsal tubercle.

HABITAT

At Killara, New South Wales, *Limnodynastes peroni* was found near small pools and small streams. It is a secretive species, even at night. The adult males could be heard calling, and a search revealed them in small holes, which were partially filled with water, and under rocks or in the banks of small streams. Frequently the hiding places were so small and so deep that it was difficult to extract the males.

This species was also observed along large streams (Guy Fawkes Creek near Ebor; pl. 28, fig. 1), a coastal lagoon (Narrabeen, near

Sydney), sluggish and grass-lined streams (near Eden, New South Wales, and Cairns, Queensland), and swamps (Binna Burra, Queensland; pl. 32, fig. 1). I did not find it directly associated with large and swiftly flowing streams or rivers. Wherever it was found it was generally hidden away in some recess.

VOICE

The call is a deep, guttural "toc" repeated every few seconds. When the male begins to call, the vocal sac in the throat is inflated, and it remains inflated between the individual calls. At each "toc" there is a pronounced contraction of the lateral abdominal wall.

A single male that was heard calling near Cairns, Queensland, had a call that was shorter and higher. This resembled the sound made by tapping the finger on a wooden table.

BREEDING HABITS

Limnodynastes peroni deposits its eggs in a foam nest, which floats on the surface of the water (pl. 36, fig. 3). It is mentioned above that the males tend to secrete themselves in hidden areas such as crevices and holes that contain water. In these situations the egg masses are deposited.

Unmated females with eggs in the uterus,

when collected, were generally in the open and not in the secluded places of the sort occupied by the males, which may suggest that the male selects the site for spawning and that the females are attracted to him.

The egg mass itself is large. The one shown in plate 36, figure 3, measured 6 by 10 cm. (It should be mentioned that this egg mass was not found in the exposed situation as shown. Originally it was at the edge of a tiny stream under an overhanging rock. It was pulled out into open water to be photographed.)

The egg mass contains many bubbles that range in size from tiny spheres up to those with a diameter of 6 mm. When eggs in the uterus are stripped from females, the jelly never becomes frothy. It is, however, very sticky, more so than that of *Rana pipiens*, for example. When the jelly is examined under the microscope it is found to contain many small, crystal-like granules. These are as clear as glass and measure about 0.10 by 0.05 mm.

The egg mass floats on the surface, and some of the developing embryos are above the water line. Such a situation may lead to disaster. A few masses were observed in which all the embryos on the top had dried up and died and only those at the bottom had hatched.

The number of uterine eggs in two females collected at Killara were found, by actual count, to be 705 and 1009. The mean diameter of the eggs from each female was 1.5 mm.

The breeding period is long at Killara. Egg masses were found August 4 (water, 13° C.), November 2, November 30 (water, 17° C.), December 6 (water, 17° C.), and December 30 (water, 19° C.) of 1952. Males were heard calling, however, until April 15, 1953, and perhaps they continue through the winter months. Newly laid eggs were found at Delegate, New South Wales, on February 20 and at Cairns, Queensland, on June 3, 1953. Fletcher (1889) found breeding individuals in February in the Sydney area.

EMBRYONIC DEVELOPMENT

The following observations were made on four groups of embryos from Killara, New South Wales. Some were from natural, others

from artificial, fertilizations. The average diameters of the ovum were 1.4 and 1.5 mm. for two groups. The animal hemisphere is dark, and the vegetal hemisphere is light.

Early development is of the *Rana* type, but there are small differences. For example, it was noticed that the pigmentation of the animal hemisphere is not uniform in the four-cell stage. Most of it is concentrated on one side, so that only half of the animal hemisphere is pigmented. This unequal distribution was also observed in the embryos of *Pseudophryne australis*, in which, however, it has a definite relation to the planes of cleavage. So far as I could tell, there is no fixed relation between the planes of cleavage and the distribution of the pigmented sector in *Limnodynastes peroni*.

In stage-14 embryos there are deeply pigmented areas on the inner side of the anterior portion of the neural folds. These probably are the cells that will form the optic cups. The folds themselves are very low.

Stage 20 is reached in six days at a temperature of approximately 15° C. The most noteworthy external characteristics are the very large pronephric swellings and the exceedingly small size of the gill filaments. The external gills are always minute. Generally each remains as a single unbranched filament until overgrown by the operculum. Hatching begins when the embryos are in stage 20, and at this time they are 6 mm. in total length.

The tadpoles are light in color. Under the microscope, the skin of the dorsal side is seen to contain an almost continuous network of golden chromatophores. The openings of the lateral lines are marked by golden spots. The skin of the ventral side of the body contains only a few pigment cells. The spiracle is on the left, and the opening of the anus is median.

The maximum size attained in the laboratory was 63 mm., and the time required to reach metamorphosis was five months. This period seems rather long, but perhaps the culture conditions were not adequate for more rapid growth.

GEOGRAPHIC DISTRIBUTION

Limnodynastes peroni occurs along the east coast of Australia from Cairns to Melbourne,

and probably in Tasmania as well (fig. 18). It is restricted almost entirely to the area east of the Dividing Range. The type locality is "New Holland."

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Tweed River (No. 8492)
 Dunoon, Richmond River (Nos. 7496, 7497)
 Lower Clarence River (No. 7526)
 Brooklana, East Dorriggo (No. 9946)
 Warrell Creek, Nambucca River (Nos. 4236-4241, 4243-4246)
 Tubrabucca, Barrington Tops, 4300 feet (Nos. 13308, 13309)
 Booral (Nos. 8324-8326)
 Bulahdelah (No. 8097)
 Legges Camp, Myall Lakes (Nos. 7908-7915)
 Broughton Island, Port Stephens (Nos. 5523, 5974)
 Hampton District (Nos. 13384-13386)
 Capertee (Nos. 7326, 7327)
 Leura, Blue Mountains (No. 4106)
 Ashfield (No. 1430)
 Waverley (Nos. 1879-1882, 1901-1903)
 Wentworthville (No. 9433)
 Parramatta (Nos. 3602, 4395, 6145)
 Killara (Nos. 4333-4338, 4360, 4389-4394)
 Lindfield (Nos. 4481-4485, 12035)
 Rushcutters Bay (Nos. 5282-5284)
 Brookvale (No. 9362)
 Katoomba (Nos. 5201, 5202)
 Illawarra (No. 7566)
 Bundanoon (Nos. 4372, 4373)
 Burrawang (Nos. 7386, 7389-7391)
 Moss Vale (Nos. 8485, 8500, 8501)

The American Museum of Natural History has specimens from:

Ben Lomond (No. 60553)
 Ebor (No. 60558)
 Glenbrook (Nos. 60554-60556)
 Pittwater (No. 60557)
 Killara (Nos. 60536-60544)
 Parramatta (No. 23874)
 Rockdale (No. 60552)
 Burradoo (Nos. 60550, 60551)
 Bodalla (Nos. 60559, 60560)
 Eden (Nos. 60661-60663)
 Delegate (Nos. 60664-60666)
 *New South Wales (Nos. 23907-23909)

Additional localities for which there are only literature records are Guntawang and Cullenbone near Mudgee (Fletcher, 1890), a few miles west of the Dividing Range.

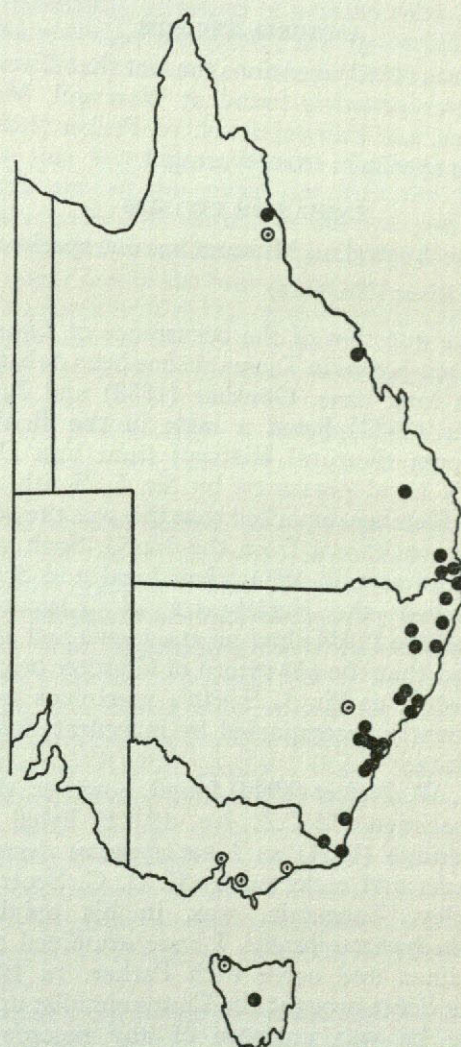


FIG. 18. *Limnodynastes peroni*. Geographic distribution.

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Eidsvold, Burnett River (Nos. 5350, 5826, 5985)
 Pimparna (No. 7409)
 Pine Mountain (Nos. 6821-6824)

The American Museum of Natural History has specimens from:

Cairns (No. 60545)
 Port Mackay (No. 23591)
 Binna Burra (Nos. 60546-60549)

An additional locality for which there is only a literature record is Millaa Millaa (Loveridge, 1935).

VICTORIA RECORDS

Lucas (1892) mentions the fact that *Limnodynastes peroni* is found at Warragul, Melbourne, and Bairnsdale. H. W. Parker (1940) lists a specimen from Warragul.

TASMANIAN RECORDS

The Australian Museum has one specimen: Ouse River (No. 6826)

The question of the occurrence of *Limnodynastes peroni* in Tasmania has been debated for a long time. Günther (1858) and Boulenger (1882) listed a male in the British Museum (Natural History) from Van Dieman's Land presented by Sir A. Smith. In 1898 Fletcher remarked that this was the only specimen known from the island. Such was still the case in 1924 when Lord and Scott described the vertebrates of Tasmania. Loveridge (1934) had no specimens and suggested that the old record of Günther be disregarded, as Sir A. Smith's specimens were frequently accompanied by inaccurate locality data.

H. W. Parker (1940) found, however, that a specimen (M.C.Z. No. 19371) listed by Loveridge (1934) as *Limnodynastes dorsalis dorsalis* and collected by E. O. G. Scott at Stanley, Tasmania, was, in his opinion, *Limnodynastes peroni*. I have examined this specimen and agree with Parker. In 1942, when Scott brought the Tasmanian list up to date, he was unaware of any records of *Limnodynastes peroni* other than the British Museum specimen. Apparently he did not know of Parker's 1940 paper.

Hewer (1951) reported a species, which, although unknown to him, was common on the northwest coast from Stanley to Cape Grim. His paper is accompanied by a fine photograph of an adult, and it is *Limnodynastes peroni*.

LITERATURE

Limnodynastes peroni was first described as *Cystignathus peronii* by Duméril and Bibron (1841). The holotype (No. 4500) and paratype (No. 4499) are in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)]. The type locality is in doubt, as this quotation shows: "Nous possédons trois échantillons qui proviennent du voyage de Péron, mais nous

ignorons le pays où ils ont été recueillis. Peut-être est-ce la Nouvelle-Hollande?" In 1854 Duméril and Bibron definitely stated that the type locality was "Nouv.-Hollande." In 1843 Fitzinger suggested the generic name *Limnodynastes*, with *peroni* as the type species.

This species has had a fairly uneventful history, there being only two main synonyms. *Limnodynastes krefftii* was described by Günther (1863a) on the basis of two adults and several juveniles from Sydney. The cotypes are in the British Museum (Natural History), and Boulenger (1882) and H. W. Parker (1940) list them as *Limnodynastes peroni*.

Somewhat later de Vis (1884a) described a small specimen from Mackay, Queensland, as *Limnodynastes lineatus*, noting that it was similar to *Limnodynastes peroni*. The following year Boulenger (1885) reduced *lineatus* to synonymy with *peroni* in a forceful manner. The cotypes of *Limnodynastes lineatus* are in the British Museum (Natural History).

Loveridge (1938) believes that *lineatus* is a subspecies. Specimens from Ebor and Barrington Tops in New South Wales and Millaa Millaa, Queensland, are referred to as *Limnodynastes peroni lineatus*. Specimens from Sydney and Blackheath in New South Wales and Brisbane, Queensland, are referred to as *Limnodynastes peroni peroni*. There is, therefore, a broad geographical overlap in Loveridge's subspecies, and current practice would be against calling these subspecies. H. W. Parker (1940) does not recognize any subspecies in *Limnodynastes peroni*.

General descriptions are found in Günther (1858, who abandoned an earlier belief that *Limnodynastes peroni* was a synonym of *Limnodynastes dorsalis*), Steindachner ("1869" [1867], as *Limnodynastes krefftii*), Keferstein (1867; 1868a, with a drawing of an adult; in both he refers also to *L. p. krefftii*), Boulenger (1882), Fletcher (1889, breeding habits), Lucas and Le Souëf (1909, with a photograph of two adults), Andersson (1913a), Harrison (1922, with a description of breeding habits), Nieden (1923), Loveridge (1935), H. W. Parker (1940, with a figure of the hand of a female), Slevin (1955, with a photograph of an adult), and Moore (1957a, with a photograph of an adult).

Procter (1921) described the scapula;

Trewavas (1933), the larynx; Johnston (1912), the parasites; Jones (1933), the pectoral muscles; Griffiths (1954), the depressor mandibulae muscle; and J. P. Hill (1894), a specimen with atypical blood vessels.

Fletcher (1890, 1892, 1894b, 1898) and Roth (1908) deal with geographic distribution. Klingelhöffer (1956) describes the habits in captivity.

References that contain but little information are Gray (1841a, as *Cystignathus peroni*), Fitzinger (1861), Krefft (1863, 1865, 1867, 1870, all as *Limnodynastes krefftii* Günther (1868a, as *Limnodynastes krefftii*), Steindachner (1868), Fletcher (1891a), Spencer (1892), Lucas (1892, 1897), Aflalo (1896), Boettger (1892), Fry (1912), Roux (1920), Lord and Scott (1924), Loveridge (1934), Scott (1942), Barrett (1943), and Hewer (1951, an "unknown" species from Tasmania that is *Limnodynastes peroni*).

Wagleria peroni (Girard, 1853, 1858) has been regarded as a synonym of *Limnodynastes peroni* by all authors from Keferstein (1868a) to H. W. Parker (1940). I find it difficult to agree fully with this opinion. The figure of the adult (Girard, 1858, pl. 3, fig. 29), as well as parts of the description, seems more applicable to *Limnodynastes tasmaniensis* than to *Limnodynastes peroni*.

Limnodynastes tasmaniensis Günther

THE SPOTTED GRASS FROG

Plate 37, figures 1-3; text figures 19, 20

DIAGNOSIS

The combination of medium size, no more than a trace of webbing on the toes, a small inner metatarsal tubercle, dark spots on a greenish back, vomerine teeth behind the choanae, and the fact that the first metacarpal is of approximately the same length as the second separates this species from any other in eastern New South Wales.

DESCRIPTION

Limnodynastes tasmaniensis is a medium-sized species that is *Rana*-like in general appearance.

The back is medium green to olive gray, with large, irregular, dark green spots. In most individuals there is a white stripe along the dorsal midline. Occasionally the spots are

symmetrically arranged in parallel rows and, if the spots are elongated, the appearance is somewhat like that of a small *Limnodynastes peroni*. The head pattern is nearly the same as that of *Limnodynastes peroni* and has the dark line from the snout to the arm, the lighter area of the upper jaw with the dark spot anterior and ventral to the eye, and the light-colored ridge from the posterior part of the upper jaw to the base of the arm.

The dorsal side of the appendages is similar in coloration to the back, with the dark areas taking the form of spots or, infrequently, of cross bars.

There is frequently a reddish tint in the light, dorsal, midline stripe and in the skin over the dorsal part of the eyeball.

The ventral surface of the body is white except for the throat, which is dusky, with a yellowish wash, in males. In preserved specimens the yellow is dissolved, leaving only the dusky hue. In most specimens there is a yellowish wash in the armpits and on the thighs.

The skin varies from smooth to slightly rough above and is smooth below.

Fletcher (1889) mentions that "the very young frogs often show a distinctly red vertebral line." He also mentions a clasping pair in which the female had the light vertebral line, but the male did not. This characteristic, which has sometimes assumed taxonomic importance, is clearly an example of polymorphism.

A male from Armidale measuring 39.1 mm. and a female from Capertee measuring 41.0 mm. are the largest New South Wales individuals that I have seen. Specimens from Adelaide, South Australia, have a maximum of 47.1 mm. for males and 48.4 mm. for females.

The body proportions of 10 males (body length, 31.7-39.1 mm.) and 10 females (body length, 32.2-39.4) from eastern New South Wales are: tibia length/body length ratio of males, 0.41 ± 0.01 (0.37-0.45), of females, 0.39 ± 0.01 (0.38-0.41); head length/body length ratio of males, 0.34 ± 0.01 (0.32-0.38), of females, 0.33 ± 0.01 (0.30-0.36); head width/head length of males, 1.05 ± 0.02 (0.98-1.13), of females, 1.01 ± 0.02 (0.97-1.07).

The tongue is broad and has no indentation on the posterior edge (fig. 19). The vomerine teeth are posterior to the choanae and in two

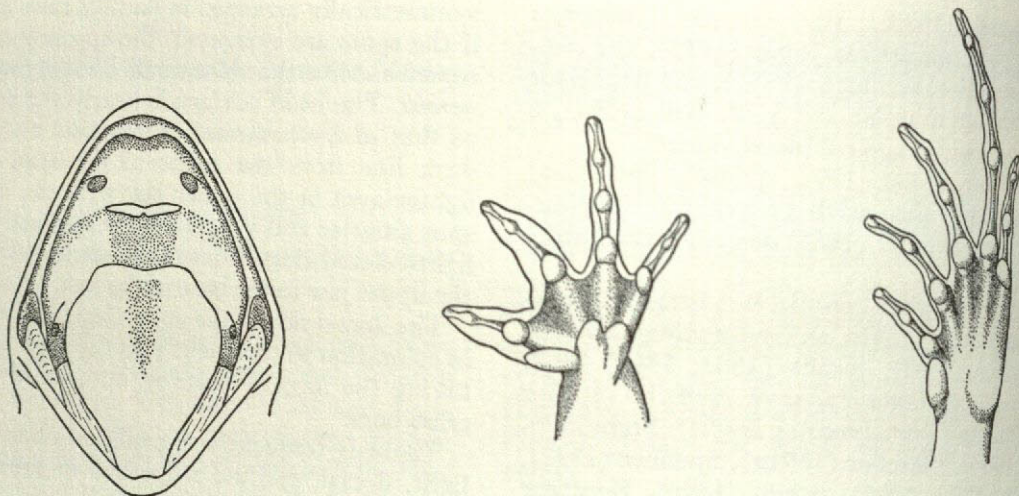


FIG. 19. *Limnodynastes tasmaniensis*. Open mouth, hand, and foot. A.M.N.H. No. 60585. Booroolong Creek, near Armidale, New South Wales.

long, slightly curved series that nearly meet on the midline and extend laterally to the level of the outer edge of the choanae.

The tympanic membrane is indistinct.

The fingers are not webbed (fig. 19). The first two of the female have lateral flanges, which are larger on the median than on the outer side. The male has inconspicuous brown nuptial pads on the first two fingers. There are three elongate metacarpal tubercles, one inner and two outer. The sequence of finger lengths is $3 > 2 > 4 > 1$.

There is an interesting relation between the reproductive state of the males and the structure of the hand. Breeding males normally have nuptial pads consisting of numerous brown spines. In a few males of breeding size the first two fingers have distinct flanges. These individuals had poorly developed nuptial spines, so they probably were collected after the breeding season. The flanges are not so large as in breeding females, but nevertheless they are surprisingly well developed.

The toes have a rudimentary web. There are always a very small inner metatarsal tubercle and often a minute outer one. The frequency of specimens with the outer metatarsal tubercle in three small samples from New South Wales is as follows: Capertee, 85 per cent (13 specimens); Burradoo, 57 per cent (14); Armidale region, 79 per cent (19); frequency for the total of 46 specimens, 74 per cent.

HABITAT

Limnodynastes tasmaniensis occupies a variety of habitats. I have found egg masses in shallow, grass-lined ditches, small pools, grassy marshes, and in shallow ponds (pl. 29, fig. 1). In addition, the adults were found along streams (pl. 28, figs. 1, 2) and lakes (pl. 30, fig. 2). It is common in the moist coastal area as well as in the drier interior.

VOICE

The call of *Limnodynastes tasmaniensis* is a very rapid "uk-uk-uk-uk . . .," reminding one of a small boy imitating a machine gun.

BREEDING HABITS

Egg masses were observed August 1 (Prospect Reservoir, near Parramatta, New South Wales), September 20 (Bowral, New South Wales), October 25 (Mt. Stromlo, Australian Capital Territory), and November 16 (Uralla and Armidale, New South Wales). Fletcher (1889) states that it is "about the earliest of the larger species to be heard croaking and to be found breeding after hibernation, as it is about the last to leave off before this period." He mentions collecting a clasping pair January 30 and that breeding occurs as early as the middle of July. Harrison (1922) "found the spawn of this widely distributed species in almost every month of the year, both in running creeks and stagnant ponds." The specific dates that he mentions are September and November 8. He also observed that "this

frog usually spawns only after rain," but on one occasion he found early embryos "in the middle of a prolonged drought."

According to Fletcher (1889) the male clasps the inguinal region of the female; this fact has been mentioned by many observers.

EMBRYONIC DEVELOPMENT

Two groups of *Limnodynastes tasmaniensis* embryos were studied. The first was a natural spawning from Prospect Reservoir, near Parramatta, New South Wales. These embryos were collected on August 1, 1952. The second group was from an artificial fertilization of the ova of a clasping pair collected at Burradoo, New South Wales, on September 20, 1952. The ova are small, averaging 1.3 mm., and the animal hemisphere is dark brown, and the vegetal hemisphere is pale.

The following notes were made on the second group, which was kept in an incubator at 20° C. during early development. The interval between first cleavage and stage 20 is about 130 hours. At a temperature of approximately 15° C. the time required for this interval is about 170 hours.

Early development does not differ appreciably from that of *Limnodynastes peroni*. The external gill filaments are never very large.

Many of the tadpoles were killed by a fungus infection. A single individual transformed after being in the laboratory for four and a half months. It reached a length of 46 mm. When it was a mature tadpole, the dorsal body skin was very dark. There was a striking difference in the pigmentation of the anterior and posterior halves of the ventral surface. In the posterior half, a layer of golden chromatophores covered the viscera, but the skin of the anterior portion was almost completely transparent.

GEOGRAPHIC DISTRIBUTION

Limnodynastes tasmaniensis is widely distributed in eastern and southeastern Australia from Cooktown, Queensland, to Port Lincoln, South Australia (fig. 20). It also occurs in Tasmania. In New South Wales most of the locality records are away from the coast. The type localities are Tasmania and "New Holland."

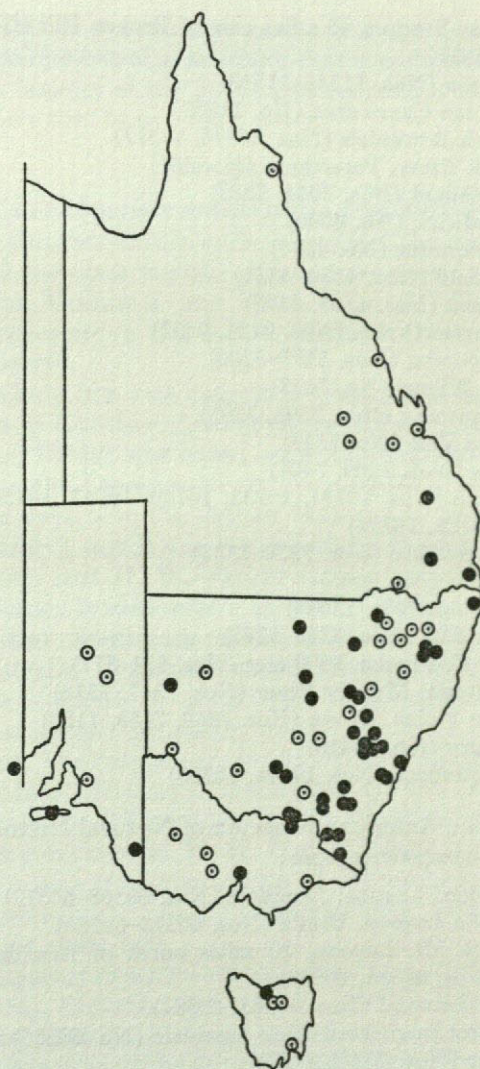


FIG. 20. *Limnodynastes tasmaniensis*. Geographic distribution.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Richmond River (Nos. 5075, 5076)
 Moree district (Nos. 7518, 7521)
 Pilliga (No. 11607)
 Bearbong, Murrumbidgee (No. 7402)
 Darling River floods (Nos. 4739-4751)
 Nyngan (No. 13674)
 Dandaloo, Bogan River (Nos. 7537-7545)
 Dunedoo (No. 10526)
 Guntawang, Mudgee (Nos. 7368-7371)
 Capertee (Nos. 10774, 10775)
 Lucknow, Orange (No. 7507)
 Bathurst (No. 4280)

Topar Station, 45 miles east of Broken Hill (No. 9552)

Oberon (Nos. 11546-11548)

Jenolan Caves area (No. 11882)

South Bowenfels (Nos. 13376, 13377)

Cook River, Petersham (No. 381)

Smithfield (Nos. 2864, 2882)

Randwick (No. 4006)

Parramatta (No. 4291)

Ashfield (Nos. 4330, 4331)

Killara (Nos. 4361, 4395)

Wentworthville (Nos. 9431, 9432)

Katoomba (Nos. 5197-5200)

Mt. Wilson (No. 7473)

Burrawang (Nos. 7393, 7395)

Moss Vale (No. 7523)

Yass (Nos. 7400, 7401)

Yanco (Nos. 10731, 10732, 10740, 10743, 10750-10752, 10754)

Bungendore (Nos. 7330-7332)

Tumut (No. 9645)

Talbingo (No. 12086)

Berridale (Nos. 5228-5230)

Mt. Kosciusko, 5500 feet (Nos. 574-577)

Mulwala, Murray River (Nos. 7317, 7318)

Emu Plains, Urana (Nos. 7349, 7153, 7154)

Albury (No. 13418)

Narrandera (Nos. 10741, 10753)

The American Museum of Natural History has specimens from:

Thomas Lagoon, Armidale (Nos. 60568-60572)

Uralla Lagoon, Uralla (Nos. 60573-60580)

Black Mt. Lagoon, 20 miles north of Armidale (Nos. 60581, 60582)

Ben Lomond (Nos. 60583, 60584)

Booroolong Creek, near Armidale (No. 60585)

Ebor (Nos. 40288, 60586)

Capertee (Nos. 60588-60600)

Parramatta (Nos. 23870-23873)

Guilford, near Sydney (No. 60619)

Burradoo (Nos. 60601-60614)

Bundanoon (No. 13313)

Saw Pit Creek, near Kosciusko (Nos. 60616, 60167)

Delegate (No. 60618)

Albury (Nos. 60587, 60615)

Additional localities mentioned in the literature are: Narrabri, Coolah, Hay, and Wagga (Fletcher, 1890); Kiacatoo Station near Condobolin (Fletcher, 1891a); Wellington Caves, Wentworth, and Waroo (Fletcher, 1892); Glen Innes, Inverell, and Tamworth (Fletcher, 1894b); Bundy, 20 miles south of Moree, and Keera, 15 miles southeast of Bingara (Slevin, 1955); Wilcannia (Fry, 1915).

AUSTRALIAN CAPITAL TERRITORY RECORDS

The Australian Museum has a specimen from:

Canberra (No. 12923)

The American Museum of Natural History has specimens from:

Canberra (Nos. 60625, 60626)

Mt. Stromlo (Nos. 60627-60629)

QUEENSLAND RECORDS

The Australian Museum has specimens from:

*Flinders River (No. 6780)

Eidsvold (Nos. 5503, 5795-5806, 5911-5913, 5919, 5920, 6216)

Moola (No. 11702)

Brisbane (No. 5858)

The Flinders River flows from the vicinity of Hughenden to the Gulf of Carpentaria. As the site of collection is not known, this locality cannot be put on the map.

The American Museum of Natural History has some juvenile specimens from:

Eidsvold (Nos. 13314-13319)

Additional localities, which are mentioned in the literature, are: Cooktown, Port Mackay, and Rockhampton (H. W. Parker, 1940); Retro (20 miles west of Capella), Margenta (near Retro), Talafa (20 miles south of Emerald), Coomooboolaroo (15 miles south of Duaringa), and Callandoon (near Goondiwindi), all listed by Slevin (1955).

VICTORIA RECORDS

The American Museum of Natural History has specimens from:

Kiewa River flats (Nos. 60620-60624)

Coburg, 5 miles north of Melbourne (Nos. 50220-50223)

Melbourne (Nos. 50224-50226)

Additional localities, for which I have literature records only, are: Ballarat (Fletcher, 1891a); Heidelberg, Carrum, Bairnsdale, Maryborough, and Sandhurst (Lucas, 1892).

TASMANIA RECORDS

The Australian Museum has specimens from:

Ulverstone (Nos. 7595, 7596)

Localities mentioned in the literature are: Longford and Launceston (Fletcher, 1898); Hobart and Westbury (English, 1910).

SOUTH AUSTRALIA RECORDS

The Australian Museum has specimens from:

Kingscote, Kangaroo Island (No. 7134)
Deep Creek (20 miles from Kingscote), Kangaroo Island (No. 7159)
Narracoorte (No. 6647).
Port Lincoln (Nos. 6830-6833, 6840)

Additional localities mentioned in the literature are: Wilpena (Loveridge, 1935), Adelaide (H. W. Parker, 1940), and Mt. Mary Range (Boehm, 1943).

COMMENTS

The status of the South Australia frogs that are similar to *Limnodynastes tasmaniensis* is not fully settled. Günther (1867) described two specimens from Adelaide as *Limnodynastes platycephalus*. Boulenger (1882) reexamined the types and also regarded them as distinct species. Fry (1915) believed that a specimen from Wilcannia, New South Wales, should be regarded as *Limnodynastes platycephalus*. It differed from *Limnodynastes tasmaniensis* primarily in "the most extensive vomerine teeth, which extend outwards well beyond the choanae, the broader head . . ." H. W. Parker (1940) reexamined the cotypes and was "unable to find any characters whereby *platycephalus* may be distinguished from *tasmaniensis*." Fry (1915) thought that the two forms might even occur together, and Loveridge (1935) listed both from Kangaroo Island, South Australia.

I do not feel that a valid case has been made for the distinctness of *Limnodynastes platycephalus*. Much more material, as well as field observations and laboratory experiments, is required to settle the matter.

The peculiar situation with respect to the flanges on the fingers of males is mentioned above in the description. The fact that the flanges are present when the male nuptial pads show a minimum of development suggests a relation to the hormonal cycle of the male. It should be emphasized that the presence of the flanges in adult males during the non-breeding season does not indicate the

return to a neutral situation but the actual development of a structure that is common in the females of the genus *Limnodynastes* (and others that have a foam nest).

LITERATURE

Limnodynastes tasmaniensis was described by Günther (1858, with a figure of the adult and the open mouth). He had six specimens from Tasmania and New Holland. These cotypes are in the British Museum (Natural History).

There are two principal synonyms, both due to Günther. *Limnodynastes affinis* (Günther, 1863a) was based on a single specimen from the Clarence River, New South Wales. The type is in the British Museum (Natural History), and it was listed both by Boulenger (1882) and H. W. Parker (1940) as *Limnodynastes tasmaniensis*. In 1867 Günther described specimens from Adelaide, South Australia, as *Limnodynastes platycephalus*. It was thought to differ from *Limnodynastes tasmaniensis* primarily in the shape of the head. The cotypes are in the British Museum (Natural History). Boulenger (1882), Fry (1915), and Loveridge (1935) regarded this as a good species. H. W. Parker (1940), however, lists it as a synonym of *Limnodynastes tasmaniensis*, as did Steindachner (1868) many years ago.

General descriptions are given by Günther (1858), Steindachner ("1869" [1867]), Keferstein (1867), McCoy (1880, with colored illustrations of the adults, head, open mouth, hand, and foot), Boulenger (1882, who also describes and figures *Limnodynastes platycephalus*), Fletcher (1892), Lucas and Le Souëf (1909, with a photograph of the adult and reproductions of McCoy's figures), English (1910, with colored figures of the adult), Fry (1915, with a consideration of the *Limnodynastes platycephalus* problem), Nieden (1923, also as *Limnodynastes platycephalus*), Waite (1929, with figures of the palate, hand, and foot, and a reproduction of Günther's figure of the adult), Loveridge (1935, as *Limnodynastes platycephalus*), H. W. Parker (1940, with a figure of the hand of the female), Slevin (1955, with a photograph of an adult that does not resemble a typical individual and may not even be of this species), and Moore (1957a, with a photograph of the adult).

Data on habits and distribution are given by Fletcher (1889, 1890, 1891a, 1892, 1894b, 1898), Lucas (1892, 1897), Harrison (1922), and Loveridge (1934).

Abbie and Adey (1950), described the brain; Edmund Müller (1932), the intermaxillary glands; Jones (1933), the pectoral muscles; William K. Parker (1881), the skull; Nicholls (1916), the vertebrae; and Johnston (1912), the parasites. Kinghorn (1932) reported the occurrence of specimens buried 6 to 8 feet below the surface of the ground.

Limnodynastes tasmaniensis is a popular terrarium animal in Europe. Descriptions of its behavior in captivity are given by Oeser (1954), W. Müller (1951), Luther (1933), Hesse (1932), Klingelhöffer (1931, 1956), Weingand (1927, 1928), Geyer (1928a, 1928b), Rahecek (1926), Wolterstorff (1926a, 1926b), and Zerneck (1926).

Minor references are Peters (1863), Krefft (1863, 1865, 1867, 1869, 1870, as *tasmaniensis* and *affinis*), Keferstein (1867, as *Limnodynastes peronii* var. *tasmaniensis* and var. *rugulosus*), McCoy (1867, as *Limnodynastes tasmanicus*), Günther (1868a, as *Limnodynastes affinis* and *Limnodynastes platycephalus*), Boettger (1892), Aflalo (1896), Spencer (1892), Lord and Scott (1924), Harrison (1921), Kinghorn (1924, with a figure of a deformed adult), Waite (1927), Noble (1931), Condon (1941, as *Limnodynastes platycephalus*), Scott (1942), Barrett (1943), and Boehm (1943).

The possibility that *Wagleria peroni* (Girard, 1853) may be a synonym of *Limnodynastes tasmaniensis* is discussed above in the literature section for *Limnodynastes peroni*.

Limnodynastes fletcheri Boulenger

THE LONG-THUMBED FROG

Plate 38, figure 1; text figures 21, 22

DIAGNOSIS

The elongate first metacarpal, slight but definite webbing of the toes, and vomerine teeth posterior to and extending only to the level of the inner edge of the choanae differentiate this species from the others in eastern New South Wales.

DESCRIPTION

The dorsal surface is olive-brown, with large and irregularly shaped black blotches.

The ventral surface is white, except for the throat region which may have a brownish wash.

The back is slightly granular, and the ventral surface is smooth.

The largest specimen that I have seen has a body length of 56 mm. The body proportions of a female 42.6 mm. in length are: tibia length/body length, 0.42; head length/body length, 0.35; head width/head length, 1.02. The tibia length/body length ratio of 12 adults (body length, 49.0–55.0) from Yanco, New South Wales, is 0.43 ± 0.01 (0.40–0.45).

The tympanic membrane is very indistinct; in fact, it is almost imperceptible.

The fingers are not webbed (fig. 21). The first metacarpal is elongate, as in *Limnodynastes peroni*. There is a prominent tubercle at the distal end of the second, third, and fourth metacarpals. There is a well-developed inner metacarpal tubercle and in some specimens a small median one. The sequence of finger lengths is $3 > 2 > 1 > 4$. Slevin (1955) collected a male with "a swollen thumb and bone protruding as in *L. peronii*." Presumably this bone acts as a nuptial spine.

The toes have a slight though definite web (fig. 21) in contrast to those of *Limnodynastes peroni*, *Limnodynastes tasmaniensis*, *Limnodynastes ornatus*, and *Limnodynastes salmini*, which have no web or the merest traces of one. There is a small inner metatarsal tubercle.

The vomerine teeth are short, reaching only to the level of the inner edge of the choanae (fig. 21). The tongue is broad and rounded posteriorly.

HABITAT

I collected this species only at Uralla Lagoon (pl. 30, fig. 2) where it was at the edge of the water and associated with *Limnodynastes tasmaniensis*. Slevin (1955) found individuals "under old logs or bark in moist depressions in paddocks."

There are no published records of the voice or breeding habits. The lack of information seems to be due to its occurrence in areas not often visited by zoologists as well as its frequently being confused with *Limnodynastes tasmaniensis*.

GEOGRAPHIC DISTRIBUTION

Limnodynastes fletcheri occurs in New South Wales and southern Queensland west

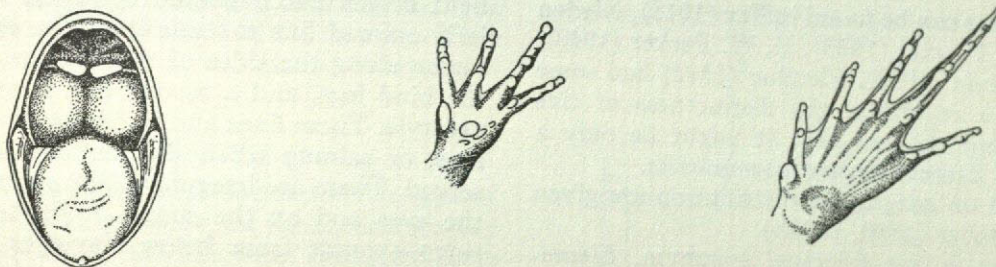


FIG. 21. *Limnodynastes fletcheri*. Open mouth, hand, and foot. A.M.N.H. No. 60638. Uralla Lagoon, Uralla, New South Wales.

of the Dividing Range (fig. 22). The type locality is Guntawang, New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Moree district (Nos. 7517-7518, 7520)
- Tarrion Creek, Brewarrina (Nos. 8000-8003, 8005)
- Pilliga (Nos. 11608, 11609, 11612-11615)
- Darling River floods, Wilcannia (Nos. 4731-4733, 4735, 4737)
- Yanco (Nos. 10730, 10733-10739, 10742, 10744-11749, 11755-11757)
- Emu Plains, Urana (No. 7352)

The American Museum has specimens from:

- Boggabilla (No. 60637)
- Uralla Lagoon, Uralla (No. 60638)

Other localities mentioned in the literature are: Guntawang and Wentworth (H. W. Parker, 1940).

QUEENSLAND RECORDS

The Australian Museum has a specimen from:

- Goondiwindi (No. 5509, a cotype of *Limnodynastes marmoratus* Lamb)

Other localities mentioned in the literature are: Waroo (I assume that Warroo is meant) and St. George district (H. W. Parker, 1940); Keera Station, near Bingara (Slevin, 1955).

COMMENTS

Australian Museum No. 5509 is a cotype of *Limnodynastes marmoratus* (Lamb, 1911). I agree with Fry (1915) that this is conspecific with *Limnodynastes fletcheri*.

LITERATURE

Limnodynastes fletcheri was described by Boulenger (1888) on the basis of two specimens from Guntawang, near Mudgee, in New South Wales. The types are in the British Museum (Natural History). They were sent to him by J. J. Fletcher. Other general de-

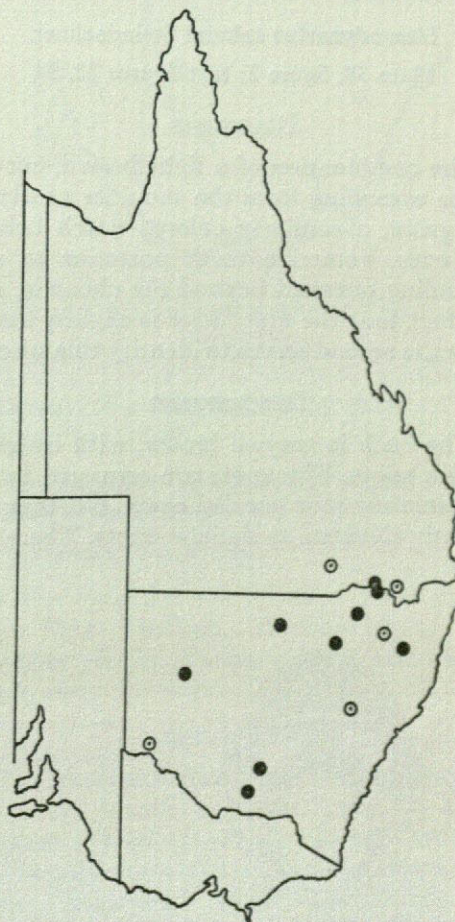


FIG. 22. *Limnodynastes fletcheri*. Geographic distribution.

scriptions can be found in Fry (1915), Nieden (1923), Procter (1923), H. W. Parker (1940), and Slevin (1955). Fletcher (1892) had some question regarding the distinctness of this form and thought that it might be only a race of *Limnodynastes tasmaniensis*.

Data on geographic distribution are given by Fletcher (1890, 1894b).

There is one principal synonym. *Limnodynastes marmoratus* was described by Lamb (1911) on the basis of material from Goondiwindi, Queensland. He noted, "This frog is closely allied to *L. tasmaniensis*, from which it differs by not having an outer metatarsal tubercle; vomerine teeth much straighter and interrupted; no vertebral line in immature or adult." A cotype is in the Australian Museum, and Fry (1912, 1915) examined it and concluded it to be identical with *Limnodynastes fletcheri*. Nieden (1923), Loveridge (1935), and H. W. Parker (1940) concur.

Limnodynastes salmini Steindachner

Plate 38, figure 2; text figures 23, 24

DIAGNOSIS

The combination of a light brown, curved stripe extending from the shoulder nearly to the groin, a similarly colored patch behind the eyes, vomerine teeth posterior to and extending outward beyond the choanae, and the fact that the first finger is slightly longer than the second serves to identify this species.

DESCRIPTION

The back is grayish brown, with irregular brown spots. The spots are arranged in approximately four parallel rows, and they are slightly elevated as shallow warts. There is a

light brown patch behind the eyes. A similarly colored line extends from the shoulder region along the sides of the body nearly to the hind legs, and a second line is over the urostyle. These lines and patch become pink, rose, or salmon when the animals are preserved. There are irregular black spots below the eyes and on the snout. A light-colored ridge extends from below the eyes to the arms. The sides are olive-gray, with dark mottlings.

The ventral surface is almost entirely whitish, but the legs have a bluish tint, and the throat is lightly mottled.

This is a stocky species that resembles *Limnodynastes fletcheri* in general body form. The body proportion ratios of the single specimen, which is 34 mm. in length, in the American Museum of Natural History are: tibia length/body length, 0.40; head length/body length, 0.38; head width/head length, 1.04.

The tibia length/body ratio is 0.41 ± 0.00 (0.40–0.42) for 11 specimens in the Australian Museum that vary from 47.0 to 70.1 mm. in body length. The largest specimen that I have seen is 70.1 mm. in body length.

The tympanic membrane is relatively distinct.

The fingers are not webbed (fig. 23). The length sequence is $3 > 1 > 2 = 4$. There is a large inner metacarpal tubercle, and there is a large, divided, outer metacarpal tubercle. There are prominent tubercles at the distal ends of the metacarpals.

The toes are not webbed (fig. 23). There is a medium-sized inner metatarsal tubercle, and there is either no, or a tiny, outer metatarsal tubercle. There are prominent tubercles at the base of each toe.

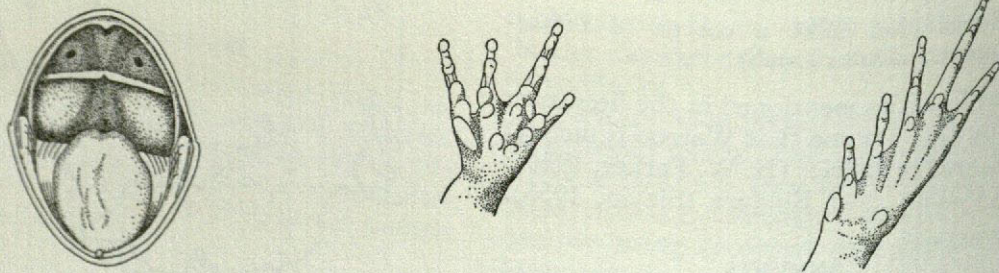


FIG. 23. *Limnodynastes salmini*. Open mouth, hand, and foot. A.M.N.H. No. 60636. St. Lawrence, Queensland.

The tongue is broad and oval (fig. 23). The vomerine teeth are behind the choanae. They meet at the midline and extend outward beyond the choanae.

HABITAT

I have no field information for this species. The total information on its natural history is contained in the following statement from Slevin (1955). The frogs were "taken in paddocks drying out from recent rains, but with a few mudholes left. The frogs were under old logs and pieces of bark wherever there was sufficient moisture left. The two from Bundy were under the bark of a fallen tree."

GEOGRAPHIC DISTRIBUTION

Limnodynastes salmini occurs along the east coast from Port Mackay (Bowen) in Queensland to the Clarence River in New South Wales and inland in southern Queensland and New South Wales (fig. 24). The type locality is given as "Australia."

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Lismore, Richmond River (Nos. 5062-5066)
Tarrion Creek, Brewarrina (No. 8004)
Goangra, near Walgett (No. 7342)
Pilliga (Nos. 11610, 11611)
Bearbong (No. 7404)
Warren (Nos. 7363, 7364)
The Plains, Nyngan (Nos. 11744-11746)
Darling River floods (= Wilcannia?) (Nos. 4708-4730)

Other localities mentioned in the literature are: Bathurst (Fletcher, 1889); Narrabri (Fletcher, 1890); Kiacatoo Station on the Lachlan, 20 miles below Condobolin (Fletcher, 1891a); Clarence River (H. W. Parker, 1940); and Bundy, 20 miles southeast of Moree (Slevin, 1955).

I am disregarding the old records from "Sydney" (Keferstein, 1868a; H. W. Parker, 1940), for I think the locality data may be erroneous. There are no records of more recent date.

QUEENSLAND RECORDS

The Australian Museum has specimens from:

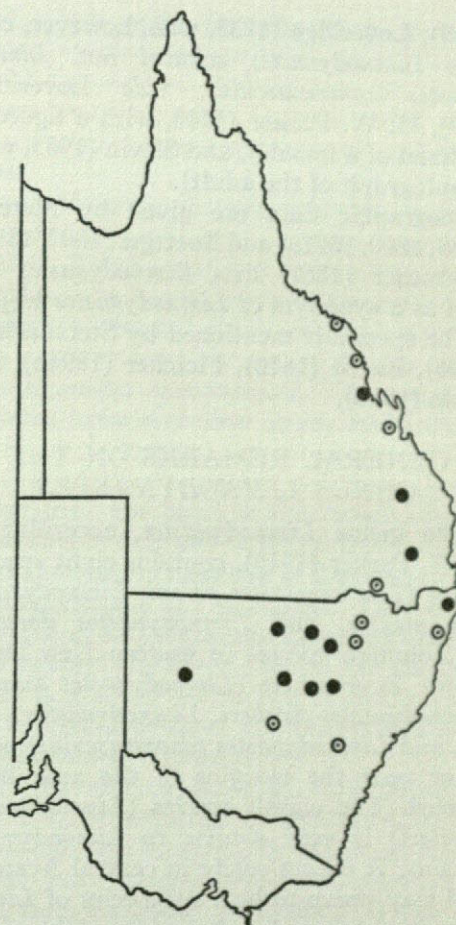


FIG. 24. *Limnodynastes salmini*. Geographic distribution.

Eidsvold (Nos. 5349, 5350, 6214, 6215)
Moola (No. 11699)

The American Museum of Natural History has a specimen from:

St. Lawrence (No. 60636)

Other localities mentioned in the literature are: Port Denison, Rockhampton, Port Mackay (H. W. Parker, 1940); and Callandoon, near Goondiwindi (Slevin, 1955).

LITERATURE

The excellent description, with figures of the adult, mouth, hand, and foot, by Steindachner ("1869" [1867]) is the first mention of *Limnodynastes salmini*. His specimens were from "Australia." Other descriptions are given by Keferstein (1868a), Boulenger (1882), Lucas and Le Souëf (1909), Nieden

(1923), Loveridge (1935, who, however, confuses *Limnodynastes salmini* and *Limnodynastes convexiusculus*, vide Loveridge, 1949), H. W. Parker (1940, with a figure of the hand of a female), and Slevin (1955, with a photograph of the adult).

Geographic data are given by Fletcher (1889, 1890, 1891a) and Boettger (1892, 1894).

Günther (1867) lists *Limnodynastes salmini* as a synonym of *Limnodynastes krefftii*.

The species is mentioned by Steindachner (1868), Krefft (1870), Fletcher (1894b), and Afalo (1896).

GENERAL REMARKS ON THE GENUS LIMNODYNASTES

The genus *Limnodynastes*, according to H. W. Parker (1940), contains eight species. Three (*Limnodynastes peroni*, *Limnodynastes tasmaniensis*, and *Limnodynastes dorsalis*) are common species in eastern New South Wales. Four others (*Limnodynastes salmini*, *Limnodynastes fletcheri*, *Limnodynastes ornatus*, and *Limnodynastes convexiusculus*) occur in or near the margins of the area being treated. The eighth species (*Limnodynastes spenceri*) is very similar to *Limnodynastes ornatus*. It occurs solely in central Australia and may prove to be a subspecies of *Limnodynastes ornatus*. As seven of the eight species occur in or near eastern New South Wales, it may not be out of place to give some general remarks on the eastern species.

For many years the genus has been divided into two groups according to the shape of the inner metatarsal tubercle.

A. Inner metatarsal tubercle large and "shovel-shaped" (or a slightly flattened half moon). These are burrowing species, somewhat toad-like in appearance, with wide heads and rounded snouts, namely, *Limnodynastes dorsalis*, *Limnodynastes ornatus*, and *Limnodynastes spenceri* (which, not being found in eastern Australia, are not here considered further).

B. Inner metatarsal tubercle much smaller and pointed posteriorly. These are non-burrowing species, more "frog-like" in appearance, with narrower heads and more pointed snouts. This group contains *Limnodynastes peroni*, *Limnodynastes tasmaniensis*, *Limnodynastes salmini*, *Limnodynastes fletcheri*, and *Limnodynastes convexiusculus*.

The members of group A can be separated

easily from the other members of the genus by the characters just given. On external features alone they might be confused with some species of *Heleioporus* or *Cyclorana*. In this case separation is readily made on the position of the vomerine teeth. These are posterior to the choanae in all species of *Limnodynastes* and between the choanae in *Heleioporus* and *Cyclorana*. Differentiation between the two members of group A is simple. *Limnodynastes dorsalis* has a prominent oval gland on the tibia, and *Limnodynastes ornatus* lacks this structure.

In group B there are the two well-known species, *Limnodynastes peroni* and *Limnodynastes tasmaniensis*. These two can be hybridized, and the offspring appear completely normal and intermediate. This fact suggests a close genetic relationship, but there is no difficulty in distinguishing between them. *Limnodynastes peroni* is the larger species; it has longitudinal stripes on the back, a much elongated first metacarpal that extends beyond the second, and the tubercle at the distal end of the first metacarpal is small. *Limnodynastes tasmaniensis* is smaller; it has spots on the back, a first metacarpal of normal proportions (equal to or slightly shorter than the second), and the tubercle at the distal end of the first metacarpal is large. There is a slight difference in the vomerine teeth of the two, those of *Limnodynastes peroni* extending laterally beyond the choanae, while in *Limnodynastes tasmaniensis* they generally do not extend beyond the outer edge of the choanae. *Limnodynastes peroni* has a single metatarsal tubercle, the inner. *Limnodynastes tasmaniensis* has an inner, and usually an outer, tubercle as well. Both species may occur in the same locality but, when they do, there is generally a difference in habitat. In both breeding is year round, at least in the Sydney area.

The character differences distinguishing these two species are recombined in various ways in the other species of the B group. As a further complication, in some areas two species tend to resemble each other more closely than they do in other parts of the range where only one exists. Thus in western New South Wales some *Limnodynastes tasmaniensis* have a color pattern similar to that of *Limnodynastes peroni*.

nastes fletcheri. In fact, specimens of the same size are frequently mixed in museum collections. The speciation of the B group of *Limnodynastes* appears to resemble that of the genus *Bufo* in North America, and especially the *Bufo americanus*-*Bufo fowleri* complex.

Limnodynastes fletcheri is apparently restricted to the areas west of the Dividing Range whereas *Limnodynastes peroni* is found only to the east. It resembles *Limnodynastes peroni* and differs from *Limnodynastes tasmaniensis* in its large size, elongate first metacarpal, its single metatarsal tubercle, and the small size of the tubercle at the distal end of the first metacarpal. It differs from *Limnodynastes peroni* in possessing a slight though definite web and in having a dorsal pattern of irregular spots and blotches rather than longitudinal stripes. The vomerine teeth differ, those of *Limnodynastes peroni* extending beyond the outer edge of the choanae, while those of *Limnodynastes fletcheri* generally extend no further laterally than the inner edge of the choanae. The dorsal color pattern gives *Limnodynastes fletcheri* a superficial resemblance to *Limnodynastes tasmaniensis*, but it can be distinguished by the characters noted at the beginning of the paragraph.

Limnodynastes salmini is another western species, but it reaches the coastal areas in northern New South Wales and Queensland. It is a large and broad-headed species. It differs from *Limnodynastes peroni* and *Limnodynastes fletcheri* in that the first metacarpal is not unduly elongate, in fact it is only slightly more elongate than the second metacarpal, and the tubercle at the distal end of the first metacarpal is large. In these respects the thumb is of the *Limnodynastes tasmaniensis* type, but the two species can be distinguished on the basis of hand structure: in *Limnodynastes tasmaniensis* the second finger is considerably longer than the first, but in *Limnodynastes salmini* the second finger is slightly shorter than the first. Perhaps the best distinguishing characteristic of this species is the pair of light-colored bands that begin in the shoulder region and, diverging, extend to the groin. The vomerine teeth of *Limnodynastes salmini* seem to extend entirely across the roof of the mouth. They ex-

tend much more laterally than in either *Limnodynastes tasmaniensis* or *Limnodynastes fletcheri* and slightly more so than in *Limnodynastes peroni*. Only a single metatarsal tubercle, the inner, is at all well developed.

Limnodynastes convexiusculus is a species of the east and north coasts of Queensland and of New Guinea that has a considerable resemblance to *Limnodynastes tasmaniensis* or to small individuals of *Limnodynastes salmini*. It is small, and the back is spotted, as it is in *Limnodynastes tasmaniensis*. The spots are elevated to form shallow warts, which do not occur in *Limnodynastes tasmaniensis*. The hand is of the "tasmaniensis" type, but it differs from the hand in that species in the possession of first and second fingers of equal length and in the large size of the tubercles on the metacarpals and phalanges. The vomerine teeth of *Limnodynastes convexiusculus* extend beyond the outer edge of the choanae. There is a single metatarsal tubercle. These last two features serve to distinguish it from *Limnodynastes tasmaniensis*.

All the eastern Australia *Limnodynastes* that I have collected or examined in the Australian Museum can be allocated to the species just enumerated with the exception of some from Eidsvold, Queensland. These exceptional individuals are of the general *tasmaniensis* type, but they have a thumb of the *peroni* type. In common with *Limnodynastes tasmaniensis* they are of medium size, the back is spotted, the outer metatarsal tubercle is well developed, the vomerine teeth terminate laterally at the level of the inner border or the middle of the choanae, and there is the merest trace of a web. In *Limnodynastes tasmaniensis* from other areas the first metacarpal is slightly shorter than the second, and there are nuptial pads on the first two fingers. In the Eidsvold series the first metacarpal is slightly longer than the second (but not so much so as in *Limnodynastes peroni* or *Limnodynastes fletcheri*) and, in some specimens, has perforated the skin to form a nuptial spine.

I feel that it would be unwise on the basis of the available data to designate the Eidsvold specimens as a different species or subspecies. They differ from typical *Limnodynastes tasmaniensis* only slightly. The increased de-

velopment of the first metacarpal and its use as a nuptial spine represent a trend noticed in two other species of *Limnodynastes*, and it is not surprising that it should occur to a slight degree in a wide-ranging and variable species such as *Limnodynastes tasmaniensis*.

The problem posed by these Eidsvold frogs is not settled. It is, moreover, only one of a series of unsettled problems arising from attempts to classify the species of the genus *Limnodynastes*. Two other interesting problems are, first, the relation of *Limnodynastes salmini* and *Limnodynastes convexiusculus* and, second, the status of the *tasmaniensis*-like frogs of South Australia that were formerly regarded as *Limnodynastes platycephalus*.

Kyarranus sphagnicolus Moore

THE SPHAGNUM FROG

Plate 38, figures 4, 5, 8; plate 39, figure 1; text figures 25, 26

DIAGNOSIS

A combination of the following characteristics distinguishes this species from all others in eastern New South Wales: vomerine teeth posterior to and extending to the inner edge of the choanae; throat heavily mottled; a brown stripe from the eye to the arm, another along the flank, and still another at an oblique angle over the ilium (the last frequently extending to the midline); and a transverse black band from the cloaca to the ventral surface of the thigh.

DESCRIPTION

There is a considerable sexual difference in coloration.

The background color of the dorsal surface of the female is a rich brown or reddish brown. There may be a few or numerous small dark spots and blotches. There is a dark stripe on each side over the ilium, which may be restricted to the flank or it may extend in an anteromedian direction to meet the corresponding stripe on the other side. When these stripes meet they form a V, with the apex directed anteriorly. Another dark stripe runs from the snout, through the nostrils and eye almost to the base of the arm. This stripe widens posterior to the eye. There is another stripe along the side of the body. This may

extend from the arms to the legs, or it may be somewhat shorter. There is a horizontal dark band, frequently in the form of a much-flattened triangle, that has its apex at the cloaca and its sides extending along the posterior and ventral surfaces of the thighs.

The ventral surface varies from pale to dark brick red. Some individuals have numerous black spots on the throat. The palm shows extensive light areas. The sole is usually dark, but the toes, especially the inner ones, tend to be light.

The male tends to be greenish gray above, and the darker areas on the back are usually more extensive than in the female. The ventral surface of the male may be nearly white, except for the throat, which is heavily mottled.

There is nothing unusual about the body proportions of this species. The largest specimen collected is a male 34.4 mm. in body length. The body proportions of five females (body length, 30.3–34.0 mm.) and eight males (body length, 29.7–34.4 mm.) are as follows: tibia length/body length, females 0.43 ± 0.01 (0.42–0.45), males 0.45 ± 0.00 (0.42–0.47); head width/head length, females 1.12 ± 0.01 (1.08–1.14), males 1.19 ± 0.01 (1.14–1.24); head length/body length, females 0.31 ± 0.01 (0.30–0.32), males 0.32 ± 0.00 (0.30–0.33).

The tympanic membrane is indistinct.

The sequence of finger lengths is $3 > 2 \geq 4 > 1$. The first and second fingers of the female have flanges. The tubercles on the hand are not unduly enlarged, but in some individuals they are striking, because the hand is pigmented except for the tubercles. The dorsal surface of the thumb of the male has a brownish nuptial pad. When this is examined at a magnification of $\times 10$ it is found to consist of numerous tiny spines. The fingers are not webbed (fig. 25).

The toes are not webbed. There is an inner, but no outer, metatarsal tubercle. As is the case with the hand, the tubercles on the ventral surface of the foot are frequently colorless, and the remainder of the foot is pigmented.

The tongue is moderately broad and oval. The vomerine teeth are posterior to the choanae and extend laterally to the level of the inner edge of the choanae.

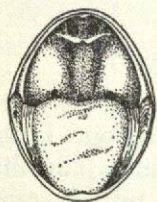


FIG. 25. *Kyarranus sphagnicolus*. Open mouth, hand, and foot. A.M.N.H. No. 60709. Point Lookout, near Ebor, New South Wales.

HABITAT

All my specimens were collected in a small area at 5000 feet on Point Lookout, near Ebor, New South Wales (pl. 30, fig. 1). Observations were made only during the daytime on November 21 and 22, and they are consequently most incomplete. Males were calling from tiny crevices between rocks near a small stream and from the depths of a sphagnum bog. A search for the adults was made by pulling apart the sphagnum mat, and they were frequently found as much as 15 cm. below the surface.

VOICE

The call of the male during the day is a low and soft growl, "gur-r-r-r-r," fading at the end. Each call requires about one second and may be repeated at intervals of about five seconds. It is exceedingly difficult to localize. The internal vocal sac is beneath the chin.

BREEDING HABITS

Many egg masses, which are of the foam type (pl. 39, fig. 1), were found in the sphagnum mat, frequently at a depth of as much as 15 cm. They were not in water, but the sphagnum was fully saturated. Generally a female was adjacent to each egg mass. The egg masses are roughly spherical and about 2.5 cm. in diameter. (One egg mass deposited in the laboratory was 6 by 5 by 2 cm.) The number of eggs in three masses was 44, 49, and 52. The jelly mass is closely packed with eggs, unlike the well-spaced eggs of *Adelotus* and *Limnodynastes*. The jelly mass contains numerous bubbles, as in *Limnodynastes* and *Adelotus*. When removed from the natural habitat and placed in water, the egg mass floats.

The male clasps the inguinal region of the female.

The breeding habitat precludes detailed observations on mating behavior under natural conditions.

EMBRYONIC DEVELOPMENT

Three groups of embryos of *Kyarranus sphagnicolus* were collected with the adults of the type series. It was not possible to study them with a microscope until two days later, when the youngest were early gastrulae. The embryos are without pigment at this stage and very large, the diameters of two being 3.2 and 3.3 mm. (pl. 39, fig. 1). The temperatures at which the embryos were kept for study fluctuated between 20.3° and 22.6° C.

Gastrulation is of the usual *Rana* type, with the formation of a 360-degree blastopore. The first noticeable departure in the pattern of development is observed in the neurular stage, at which the neural plate is narrower and shorter than in *Rana*. The neural folds close one day after the beginning of gastrulation. At the tail-bud stage, the head, the dorsal portion of the trunk, and the tail are separating from the spherical yolk mass. This process continues, and eventually the main body axis of the embryo is seen to be perched on a nearly spherical mass of yolk-laden cells. The division lines between the somites can, however, be seen to extend down into the yolk.

It requires about seven days to reach stage 20, when the embryo is 8.6 mm. in length. The gills are very short, being little more than buds. Two bumps on the spherical portion of the embryo, at its junction with the base of the tail, are the beginnings of the hind-limb buds. Melanophores make their first appearance, on the top of the head, at this time.

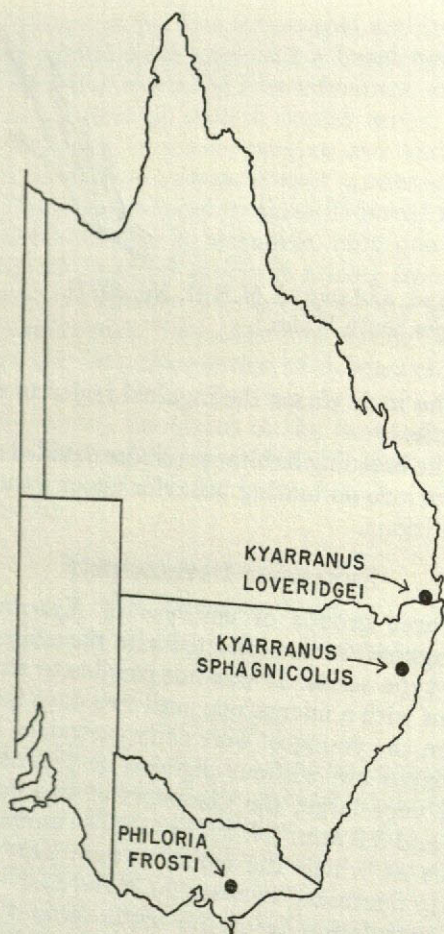


FIG. 26. *Kyarranus loveridgei*, *Kyarranus sphagnicolus*, and *Philoria frosti*. Geographic distribution.

The operculum begins to overgrow the gills when the embryo is eight days old.

Growth is extremely rapid. A length of 12.7 mm. is reached after 10 days, by which time nearly all the embryos have hatched. The hind-limb buds are prominent at this time. The 16-day embryo is 19 mm. in length, and the hind-limb bud has developed to the point at which the outlines of four toes are visible. The spiracle opens to the left, and the anal opening is median. The mouth is surrounded by an elevated corona bearing papillae. There are small jaws but no teeth. The tadpoles are lightly pigmented.

The maximum size reached by the tadpoles is 21 mm., and transformation occurs after slightly less than one month of development. The tadpoles that were given food

were not observed to feed and those given no food grew as rapidly.

GEOGRAPHIC DISTRIBUTION

Kyarranus sphagnicolus is known only from the type locality, which is Point Lookout, near Ebor, New South Wales. The altitude is 5000 feet (fig. 26).

NEW SOUTH WALES RECORDS

The Australian Museum has a specimen from:

Point Lookout, near Ebor, New South Wales (No. 16005, the holotype)

The American Museum of Natural History has specimens from:

Point Lookout, near Ebor (Nos. 60698-60709, paratypes; 63838, 63841, 63842)

The British Museum (Natural History) has a specimen from:

Point Lookout, near Ebor (No. 1958.1.1.6, a paratype)

VICTORIA RECORDS

The Australian Museum has a specimen (No. 7514) from Warragul. This locality is certainly a surprise and should be checked. I do not feel confident enough of its accuracy to show it on the distribution map (fig. 26).

LITERATURE

The genus *Kyarranus* and the species *sphagnicolus* were described by Moore (1958). The holotype is in the Australian Museum. There are no other certain references to this species. The Australian Museum, however, has a specimen (No. 7514) that was identified as *Pseudophryne coriacea*. I believe that J. J. Fletcher made the identification and, if so, some of his records of *Pseudophryne coriacea* may, in fact, be based on *Kyarranus sphagnicolus*.

A related species, *Kyarranus loveridgei*, has been incorrectly placed in the genus *Philoria* by previous authors. This matter is considered below in the section on *Kyarranus loveridgei*.

Kyarranus loveridgei (Parker)

LOVERIDGE'S FROG

Plate 38, figures 6, 7; plate 39, figure 2; text figures 26, 27

DIAGNOSIS

A combination of these characteristics serves to separate this species from all others in eastern New South Wales: vomerine teeth posterior to and extending to the level of the inner edge of the choanae; tongue broad; a brown patch extending from the snout, through the eye, to the base of the arm; throat lightly mottled; generally no horizontal black band across cloacal region, or brown stripe on flank (as in *Kyarranus sphagnicolus*); and the groin very lightly pigmented.

DESCRIPTION

The following description is based on males collected at Binna Burra in southern Queensland.

The dorsal surface is dark brown. A darker brown stripe extends from the snout to the eye and from the eye to the base of the arm. That portion of the stripe between the eye and arm is bordered dorsally by a thin, light-colored line. The flanks may have an indistinct horizontal band. The dorsal surfaces of the arms and legs may have a faint pattern of cross bars. Otherwise the dorsal surface is nearly uniform.

The throat is lightly mottled with brownish specks or spots. The remainder of the under surface is whitish. There is a dark patch below the cloaca.

Two of the three specimens have dorso-lateral ridges extending from the eye to the posterior end of the body. There are small warts on the back and legs.

This is a small frog. The largest of the three males is 27.1 mm. in body length. The other specimens are 21.8 and 25.2 mm. The mean tibia length/body length ratio is 0.41 (range, 0.40–0.42). The mean head length/body length ratio is 0.34 (range,

0.32–0.37), and the mean head width/head length ratio is 1.09 (range, 1.09–1.10).

The tympanic membrane is indistinct.

The fingers are not webbed (fig. 27). The length sequence is $3 > 2 \geq 4 > 1$. The digits are noticeably reduced (as in *Pseudophryne*). None of the males, which were taken during the breeding season, has nuptial pads.

The toes are not webbed (fig. 27). The digits are reduced in length. There is a single inner metatarsal tubercle.

The tongue is moderately broad (fig. 27). The vomerine teeth are in two oblique rows behind the choanae. They extend laterally to the level of the inner edge of the choanae.

When *Kyarranus loveridgei* and *Kyarranus sphagnicolus* are compared, it is plain that the two species are strikingly different in external appearance (pl. 38, figs. 7, 8). As far as general proportions are concerned, *sphagnicolus* is larger, with the head wider and more rounded, and the tibia longer. There are considerable differences in pigmentation. In general, *sphagnicolus* is more colorful, and it has a better-developed pattern. The spots on its throat are generally much larger than in *loveridgei*, and the stripe on the flank is much larger, as is the horizontal band across the cloacal region. The groin of *loveridgei* is lightly pigmented, whereas in *sphagnicolus* it is not different from the flanks. The males of *sphagnicolus* have prominent nuptial pads, which appear to be absent in *loveridgei*.

HABITAT

I observed this species at two sites in a single locality, namely, the rain forest of Binna Burra, Queensland. The elevations were 2700 and 3000 feet. All the adults were beneath the ground and were discovered only because the males were calling. The adults were in soft, moist earth at a depth of 4 to 6 inches.

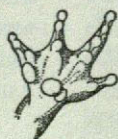
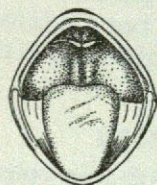


FIG. 27. *Kyarranus loveridgei*. Open mouth, hand, and foot. A.M.N.H. No. 62052. Binna Burra, Beechmont, Queensland.

VOICE

The call of the males is a slow, guttural "ork." This call has a definite resemblance to that of *Kyarranus sphagnicolus*. The entire chin area swells out when the male is calling.

BREEDING HABITS

The eggs are deposited in a crude nest (pl. 39, fig. 2), which is situated several inches below the surface in very moist, loose earth. The nest is a cavity in the shape of a flattened sphere about $1\frac{1}{2}$ inches in diameter and with smooth walls. Different nests may be very close to one another, and in one case four nests were nearly touching. No females were collected at or near the nests, though several males were found while the nests were being uncovered. In one situation the nests were in the bank of a small gully about 7 feet from the bottom. It is probable that there is never more than a foot of water in the gully.

The earliest embryos found were in the tail-bud stage. These were in individual jelly capsules. The embryos occupied the lower half of the nest, and above them there was an air space. The jelly was very moist and sticky. Each nest contained from 20 to 30 embryos.

Other nests contained larvae that were 18 to 19 mm. in length. In these nests the jelly was liquefied, and the larvae were lying in it, bending their bodies frequently.

These observations were made between December 14 and 19, 1952. The temperature of the earth surrounding the nests was 15°C .

The egg contains enough yolk to carry the developing individual to the juvenile stage. This fact, and the observation that the nests were in situations where they would probably never be flooded by streams, suggest that the larvae do not have a truly aquatic stage. The liquefied jelly mass seems to provide a suitable substitute for water during the tadpole stage.

EMBRYONIC DEVELOPMENT

Embryos of *Kyarranus loveridgei* were collected at Binna Burra, Queensland, between December 17 and 21, 1952. The early embryos are very large and pale yellow, almost white (pl. 39, fig. 2).

The general course of development is closely similar to that of *Kyarranus sphagnicolus*. There is the same precocious development of the hind-limb buds, and in some of

the *Kyarranus loveridgei* embryos, the front-limb buds were visible before the operculum closed over them. The skin is very transparent, and in the 17-mm. embryos the outlines of the fingers can be seen. The jaws are small, and there are no teeth. The external gills are extremely small.

The maximum tadpole size attained in the embryos is 20 mm. No food is required during the tadpole stage. There is the possibility, however, that feeding may occur. A small amount of clay in one of the aquaria was eaten, because it was observed to pass out with the feces. In those containers where the tadpoles had no food or clay, feces were not noticed.

The body lengths of four juveniles immediately after metamorphosis were 5.9, 6.0, 6.1, and 6.2 mm.

GEOGRAPHIC DISTRIBUTION

This species has been recorded only from Binna Burra, Queensland area (fig. 26). Strictly speaking, therefore, it should not be included among the frogs of New South Wales. I found it so close to the New South Wales boundary, however, that it seems certain that it must occur in that state.

The American Museum of Natural History has five specimens (Nos. 63839, 63840, 62051-62053).

COMMENTS

Kyarranus loveridgei and *Kyarranus sphagnicolus* are obviously closely related, as is shown by their similarities in appearance, habits, and embryology. So little is known about their distribution that nothing can be said about the relation of their geographic ranges. If the two are allopatric, it is noteworthy that such marked divergence can occur when the distance between the populations is less than 200 miles. In the case of such a small frog, with burrowing habits and presumably a low dispersal rate, it is possible that a whole series of differentiated populations will be found along the mountain ranges of eastern Australia.

LITERATURE

The first specimens of this species were mentioned by Loveridge (1935). His material was from the MacPherson Range in Queensland. (This locality is probably similar or

identical to Binna Burra.) Loveridge believed that his specimens were conspecific with *Philoria frosti* (Spencer, 1901) from Victoria (fig. 26). Subsequently H. W. Parker (1940) examined one of these frogs. He concluded that it was different enough from *Philoria frosti* to be described as new and proposed the name *Philoria loveridgei*. The holotype is in the British Museum (Natural History). Neither Loveridge nor Parker had been able to examine specimens of *Philoria frosti* and their conclusions were reached on the basis of Spencer's description, which did not include illustrations.

When the type of *Philoria frosti* was examined (Moore, 1958), it was seen that it was very different from the *Philoria* of Loveridge and Parker. A new generic name, *Kyarranus*, was proposed for the latter. This genus is close to *Limnodynastes* but differs markedly in the type of embryonic development. *Limnodynastes* has small eggs with the "typical" *Rana* or *Bufo* type of development. *Kyarranus* has large eggs with enough yolk to carry the young to the juvenile stage. It is probable that the tadpole of *Kyarranus* never has a free-swimming stage.

There are two species in the genus, *Kyarranus sphagnicolus* and *Kyarranus loveridgei*.

The American Museum of Natural History has recently received a fine series of *Philoria frosti* Spencer, which were collected at the type locality on Mt. Baw Baw, Victoria, by William Hosmer.

Uperoleia marmorata Gray

THE YELLOW-SPOTTED TOADLET

Plate 38, figure 3; text figures 28, 29

DIAGNOSIS

The combination of small size, a pair of elongate parotoid glands, and yellow or orange-red spots on the proximal part of the anterior surface of the thigh and on the middle or distal end of the posterior surface of the thigh, separates this species from all others in eastern New South Wales.

DESCRIPTION

The back is dark brown, with black spots or blotches. The brown areas are frequently so dark that the entire back appears to be a uniform sepia. There is generally a light-

colored, triangular area in the region between the eyes and the snout. Behind the eyes is a pair of parotoid glands, which are frequently lighter in color than the surroundings. The dorsal surfaces of the appendages are of the same general coloration as the back, with the dark areas in some specimens taking the form of cross bars. There are a yellow or orange-red spot on the anterior, and another on the posterior, surface of the thigh. The anterior spot is near the proximal end of the thigh and the posterior one near the distal end. In some individuals there is a short line at the posterior edge of the jaw that is of the same color as the thigh spots. The orange-red and yellow-spotted individuals may occur in the same populations. In the Armidale, New South Wales, area the yellow-spotted individuals have yellow on the posterior part of the tibial section of the legs as well as on the thighs. The dorsal surface is slightly roughened with tiny warts.

The ventral surface is dark gray, with numerous white spots. The throat of the males is black, except for a light border along the edge of the lower jaw. In quite a few specimens there is a pair of tiny white spots on the chest at the base of the arms (as in *Crinia signifera*). The ventral surface is smooth.

This is a small frog of average proportions. The largest individual seen has a body length of 29 mm. H. W. Parker (1940) reported the maximum length to be 31 mm. In a series of 12 adults from the Armidale, New South Wales, area, which vary from 22.8 to 27.7 mm. in body length, the tibia length/body length ratio is 0.38 ± 0.00 (0.36-0.39).

The fingers are not webbed (fig. 28). The length sequence is $3 > 4 > 2 > 1$. The difference between the second and the fourth is slight. There are two metacarpal tubercles, the outer being the more prominent. There are prominent tubercles at the base of the fingers.

The toes are not webbed, but they have lateral fringes (fig. 28). There is a long and pointed inner metatarsal tubercle. The outer metatarsal tubercle is somewhat shovel-shaped. In coastal populations the edge of the shovel is directed outward, but in western New South Wales populations it projects posteriorly.

The palm of the hand and the sole of the

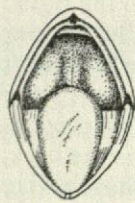


FIG. 28. *Uperoleia marmorata*. Open mouth, hand, and foot.
A.M.N.H. No. 60653. Glenbrook, New South Wales.

foot are pigmented except for the tubercles. The tubercles, therefore, are strikingly emphasized.

The sexes can be distinguished by the throat color, which is dark in males and light in females, and by the structure of the flap of skin above the cloaca, which has a smooth edge in males but has many papillae in the females.

The tongue is long and narrow. There are no vomerine teeth (fig. 28). The external nares are much nearer the tip of the snout than the eyes. (In western New South Wales populations of this species the maxillary teeth are absent.)

The tympanic membrane is invisible.

GEOGRAPHIC VARIATION

H. W. Parker (1940) recognizes two species in the genus, namely, *Uperoleia marmorata* and *Uperoleia rugosa*. *Uperoleia marmorata* is a widespread species occurring along the east coast and in Western Australia. *Uperoleia rugosa* occurs in "Queensland and New South Wales west of the dividing range."

The main differences between the two are as follows:

Uperoleia marmorata: Parotoid glands small and no other dorsal glands apart from these. With maxillary teeth. Skin of back less rough than in *Uperoleia rugosa*. Outer metatarsal tubercle elongate and distal end pointed.

Uperoleia rugosa: Parotoid glands large and frequently extending ventrally to the hinge of the jaw. Usually with large lateral glands, of same type as parotoids, extending from parotoids to groin. Skin of back rough. Maxillary teeth poorly developed or absent. Outer metatarsal tubercle wide and distal edge flattened and transverse to axis of foot.

I have examined several hundred specimens from New South Wales and Queensland. The differences listed above are present,

but I feel it is wiser to recognize only one species, *Uperoleia marmorata*, and regard the differences as the result of intraspecific variation. This opinion is based on the geographical nature of the variation and on the intermediate appearance of specimens from Tamworth, New South Wales, and Eidsvold, Queensland.

Tamworth is approximately 40 miles west of the Dividing Range. Ten specimens from this locality have maxillary teeth, as in the *marmorata* type, but the metatarsal tubercle is intermediate between the form observed in the Sydney area and the *rugosa* type of western New South Wales.

Of the 16 specimens from Eidsvold, which is about 200 miles northwest of Brisbane, that I have examined some are close to typical *marmorata*, others approach the *rugosa* type, and still others are intermediate.

I have seen specimens of typical *rugosa* from Yandenbah, Urana (near Narrandera), Dandaloo, and Nyngan, New South Wales. All these localities are farther west of the Dividing Range than Tamworth.

In summary, the situation appears to be as follows: In New South Wales the *marmorata* type occurs east of the Dividing Range. At the Dividing Range and for some distance west, at least as far as Moree, there is evidence of intergradation. Farther west the *rugosa* type is found. In Queensland the *marmorata* type occurs on the coast as far north as Brisbane.

Farther north the populations in the coastal areas are intermediate.

HABITAT

Uperoleia marmorata has an extensive distribution in Australia, which encompasses a variety of habitats ranging from arid to humid. Most of my field experience with this

species was gained in the Armidale, New South Wales, area. Furthermore observations were made only during the day, which makes them of limited value. Individuals were found in moist situations under logs and matted vegetation at the edge of lagoons (pl. 30, fig. 2). Frequently they were in small depressions only slightly larger than their bodies.

VOICE

Harrison (1922) reported that "the ordinary call note is remarkably un-froglike, and consists of a short, sharp, rather high-pitched 'akh,' explosive in character, and very difficult to locate. It sounds more like the note of some limicoline bird than that of a frog. The internal sub-gular vocal sac swells to the size of a small pea during utterance." From this description its voice would seem to resemble that of its relative, *Pseudophryne australis*. Main and Calaby (1957) also describe the call in a similar manner.

BREEDING HABITS

A female that I collected November 16, 1952, at Thomas' Lagoon near Armidale, New South Wales, had eggs in the uterus. Harrison (1922) collected recently metamorphosed juveniles at Point Stephens, New South Wales, in January.

Fletcher (1889) reported that the male clasps the inguinal region of the female. He observed females distended with ova in June. A female in captivity deposited over 200, but this spawning was not normal.

EMBRYONIC DEVELOPMENT

A single group of *Uperoleia marmorata* embryos was studied. These were obtained by the artificial fertilization of ova from a gravid female collected at Uralla Lagoon, New South Wales, on November 16, 1952. It was not possible to keep the embryos at a constant temperature, but the temperatures did not vary greatly from 20° C.

The ova are small, averaging about 1.3 mm. in diameter. The egg pigment is restricted to a small cap in the animal hemisphere, and during the cleavage and blastular stages it does not extend to the equator. In fact it does not reach the equator until stage 12.

The tail-bud stage is unusual in that the tail is better developed than the head. The latter projects only slightly from the surface of the embryo, but the tail has begun to bend laterally around the body.

The general course of development is much like that of *Crinia signifera*. There are no external gills. The operculum begins to form when the embryo is seven days old and 5 mm. in length. The suckers are round. There is a T-shaped glandular area on the head. The cross bar of the T extends across the front of the head, and the other bar extends along the dorsal midline posteriorly to the level of the otic vesicles.

The nine-day embryo is 6.3 mm. in length. Hatching begins at nine days. The melanophores are concentrated in two horizontal, sharply defined bands, one on each side of the neural tube. These extend the full length of the embryo and persist through much of the tadpole stage. With time the entire dorsal surface becomes pigmented, but the ventral skin remains transparent.

In the 10-mm. tadpoles, which are 17 days old, the spiracle opens on the left and rather far posteriorly. The anus opens to the right of the midline. There is a single row of teeth above the mouth, and there are three rows below the mouth. The papillae are short and extend around the sides and below the mouth.

GEOGRAPHIC DISTRIBUTION

Uperoleia marmorata occurs in eastern Australia from Cape York south to Jervis Bay and Narrandera in New South Wales (fig. 29). It has been reported from near Darwin in the Northern Territory and from two localities in Western Australia. There are no records of its occurrence in South Australia, Victoria, or Tasmania. The type locality is Western Australia.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Moree district (No. 7515)
Warrell Creek, Nambucca River (Nos. 4630-4632)
Gurravambi, Nambucca River (Nos. 6301, 6302)
Nambucca River (Nos. 5883, 5884)
Tamworth (Nos. 4754-4762)

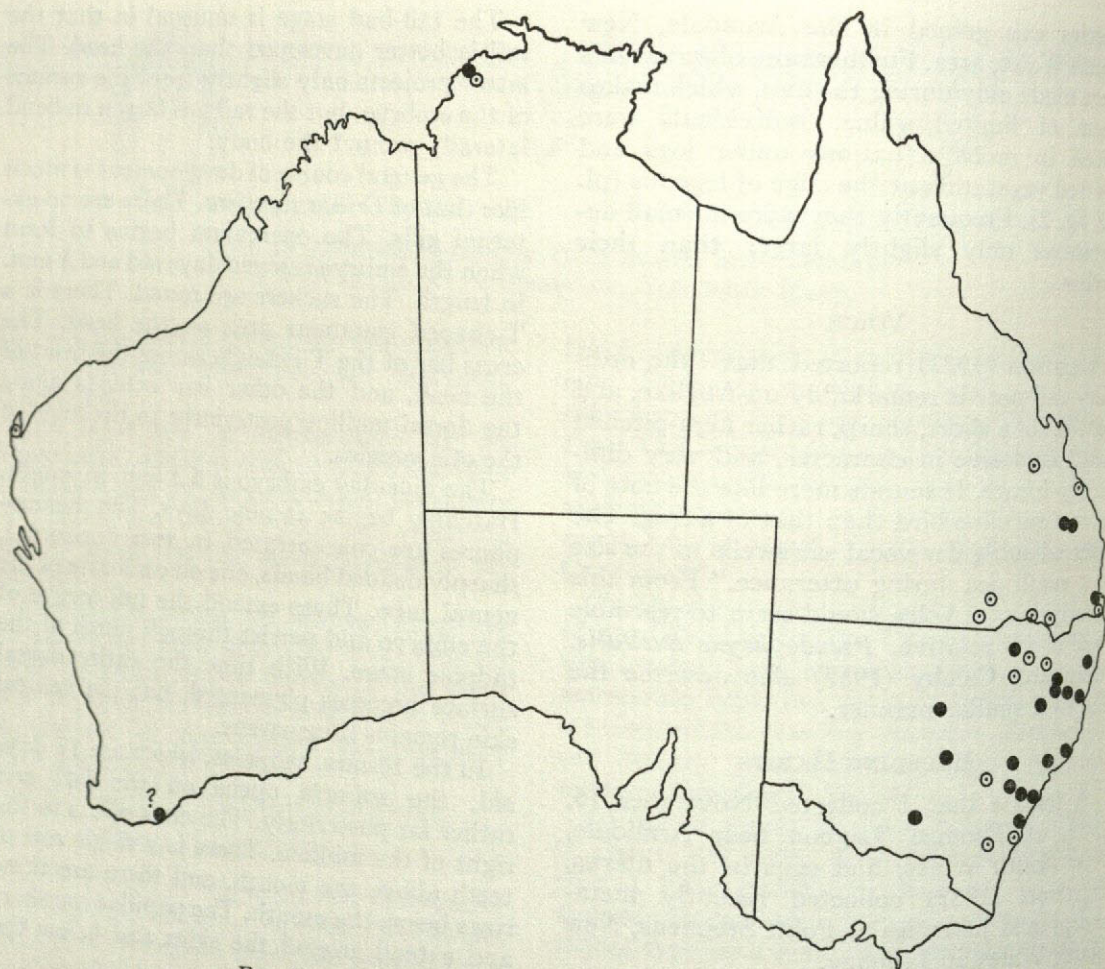


FIG. 29. *Uperoleia marmorata*. Geographic distribution.

Wellbury, via [near] Nyngan (Nos. 12712, 12806, 12807)

Bulahdelah (No. 8093)

Dandaloo (Nos. 7572, 7574)

Upper Colo, via [near] Richmond (No. 7981)

Sydney (Nos. 7478, 8453)

Cook River, Petersham (No. 382)

Randwick (Nos. 1427, 5435)

Maroubra (Nos. 4211, 4413, 5285-5287)

Kensington (No. 6930)

Clyde River (Nos. 6933, 6934)

Hampton District (No. 13393)

Jenolan Caves area (No. 11881)

Burrawang (Nos. 7379 part, 7588)

Emu Plains, Urana (Nos. 7347, 7348)

*Yandenbah (Nos. 784, 981, 984)

Uralla Lagoon (Nos. 60645-60652)

Ebor (Nos. 23879, 23880)

Macksville, Nambucca River (No. 13345)

East Maitland (Nos. 13338, 13339)

Capertee (No. 60654)

Glenbrook (No. 60653)

Sydney (Nos. 23724, 23725)

Parramatta (Nos. 23866-23868)

*"Balladelah" (No. 12950); probably Bulahdelah

Other localities mentioned in the literature are: Narrabri on the Namoi (Fletcher, 1890); Luchnow, near Orange (Fletcher, 1892); Jervis Bay, Inverell, and Bungendore (Fletcher, 1894b); Keera (Slevin, 1955).

The American Museum of Natural History has specimens from:

Clarence River (Nos. 23588, 23589)

Black Mountain Lagoon, 20 miles north of Armidale (No. 60655)

Thomas Lagoon, Armidale (Nos. 60639-60644)

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Eidsvold (Nos. 5321, 5816, 5818-5823, 5916)

Gayndah (Nos. 7427, 7430)

Brisbane (Nos. 603-606)

The American Museum of Natural History has specimens from:

Eidsvold (Nos. 13336, 13337)

Other localities mentioned in the literature are: Pimpama, Waroo, and Inglewood, which is 60 miles west of Stanthorpe (Fletcher, 1892); *Cape York, St. George District, and Colosseum (H. W. Parker, 1940); Noondoo, which is 10 miles east of Dirranbandi, Coomoboolaroo, which is 15 miles south of Duaringa, and Callandoon near Goondiwindi (Slevin, 1955).

NORTHERN TERRITORY RECORDS

The McCleay Museum at Sydney University has 17 specimens from Port Darwin.

Noonamah, 24 miles south of Darwin, is the only locality for which there is a report in the literature (Loveridge, 1949).

WESTERN AUSTRALIA RECORDS

The Australian Museum has specimens from:

King George's Sound (Nos. 6936, 6937)

Main (1954a) does not include this species in southwest Western Australia, but Main and Calaby (1957) list the Cape Range on North West Cape as a locality.

Because Western Australia is the type locality, these records take on a special significance. It might be mentioned that one of the specimens from King George's Sound has no maxillary teeth (No. 6936), and the other has poorly developed maxillary teeth (No. 6937). Such a condition is of interest in connection with the *rugosa* problem.

LITERATURE

Gray (1841a) first described the genus and the species *Uperoleia marmorata*. The locality was Western Australia. The type is in the British Museum (Natural History). In Gray (1841b) the description is repeated exactly except for the mention that the genus is part of the family Ranidae. Cope (1865) emended the name of the genus to *Hyperoleia*. Most subsequent authors followed Cope. Loveridge (1935) and H. W. Parker (1940) have reverted to Gray's original name, which seems to be the practical thing to do.

There are two principal synonyms, *Pseudo-*

phryne rugosa and *Pseudophryne fimbrianus*.

Pseudophryne rugosa was described by Andersson (1916, with a figure of the adult) on the basis of a specimen from Colosseum, southern Queensland. The type is in the Royal Museum of Natural History in Stockholm. It was thought to be closely related to *Pseudophryne mjobergii* (regarded by H. W. Parker, 1940, as *Glauertia mjobergii*), which Andersson (1913a) had described earlier from Western Australia. Loveridge (1935) thought that *rugosa* was merely a subspecies of *Uperoleia marmorata*. H. W. Parker (1940), who examined the type of *Pseudophryne rugosa*, agreed with Loveridge as to the genus, but thought it a full species, *Uperoleia rugosa*. Slevin (1955) likewise recognized two species, *Uperoleia marmorata* and *Uperoleia rugosa*.

Pseudophryne fimbrianus was described by H. W. Parker (1926, with a figure of the hand, foot, and cloacal region), from the St. George district, Queensland. The type is in the British Museum (Natural History). Loveridge (1935) made this a synonym of *Uperoleia marmorata rugosa*, and H. W. Parker (1940) made it a synonym of *Uperoleia rugosa*.

General descriptions are given by Günther (1858), Keferstein (1867, with the variety *laevigata* from "Raudewick" [probably Randwick], New South Wales; 1868a, with a figure of the adult and listing of *laevigata*), Steindachner ("1869" [1867]), Boulenger (1882, as *Hyperolia marmorata*), Lucas and Le Souëf (1909, as *Hyperolia marmorata*), Nieden (1923, as *Hyperolia marmorata*), Loveridge (1935, as *Uperoleia marmorata rugosa*, but in 1949 he changed the name to *Uperoleia marmorata marmorata*), H. W. Parker (1940, with a drawing of the anterior cranial elements and the recognition of two species, *Uperoleia marmorata* and *Uperoleia rugosa*), Slevin (1955, with the recognition of both species and photographs of each), and Main and Calaby (1957).

Notes on habits and distribution are given by Krefft (1863), Fletcher (1889, 1890, 1891a, 1892, 1894b, and 1898, all as *Hyperolia marmorata*), Harrison (1922), and Loveridge (1949).

Minor mention is made by Lütken (1863), Krefft (1865, 1867, and 1870), Günther (1867), Boettger (1892, 1894, as *Hyperolia*

marmorata), Aflalo (1896, as *Hyperolia marmorata*), and Barbour (1914).

The occurrence of the fly *Batrachomyia* as a parasite on this species is described by Krefft (1864), Skuse (1889), and Boettger (1894). The intermaxillary glands are described by Edmund Müller (1932); the pectoral muscles, by Jones (1933); the trematode parasites, by Johnston (1912); and the skull is described by William K. Parker [1881, as *Hyperolius (Uperoleia) marmoratus*].

Crinia haswelli Fletcher

HASWELL'S FROGLET

Plate 39, figure 3; text figures 30, 31

DIAGNOSIS

This species differs from all others in eastern New South Wales in possessing fringes on the toes together with red spots on the flanks and the posterior surfaces of the hind legs.

DESCRIPTION

In general coloration this is a rather drab species. The dorsal surface is olive-brown or grayish brown, with a few irregular dark spots. Eight of 10 specimens collected have a faint, narrow, and pale vertebral stripe. There is a prominent black band that extends from the eye posteriorly to the shoulder region. The edge of the upper jaw is cream colored, and this light area usually extends back to the arms. There is a glandular area in the skin between the posterior edge of the jaws and the arms. The dorsal surfaces of the appendages resemble the back in being dark, but they may have faint cross bars. The dorsal half of the iris is golden, and the ventral half is brown.

The ventral surface is quite dark. The

throat is a dark grayish brown or black. The ground color of the area posterior to the pectoral girdle is somewhat lighter, with white or pinkish spots. The abdominal skin is granular. There is a glandular area on the flank just anterior to the hind leg.

The only striking aspect of coloration is the presence of prominent, brick red areas on the hind legs. These are largely restricted to the posterior of the femoral and tibial sections of the leg, but in some specimens there is a red spot on the flank just anterior to the leg.

This is a small species. The largest specimen I have seen is 32 mm. in body length. The body proportions of the 10 specimens in the American Museum of Natural History, which are 26.6–31.9 mm. in body length, are: tibia length/body length, 0.41 ± 0.00 (0.40–0.43); head length/body length, 0.33 ± 0.01 (0.31–0.36); head width/head length, 1.09 ± 0.02 (1.05–1.17).

The tympanic membrane is indistinct.

The fingers are long and without a web (fig. 30). The length sequence is $3 > 4 > 2 > 1$. There are prominent tubercles on the fingers and two on the metacarpals.

The toes are long, with prominent lateral flanges. There are a small, inner, metatarsal tubercle at the base of the first toe and prominent tubercles on the toes.

The tongue is narrow (fig. 30). The vomerine teeth are in two oval clusters posterior to the level of the internal choanae.

HABITAT

Crinia haswelli was collected at night in three localities. On September 13, 1952, males were calling in Ettymalong Swamp, Ocean Beach (near Woy Woy), New South Wales. The temperature of the air was 10°C . and that of the water 14°C . The frogs were in

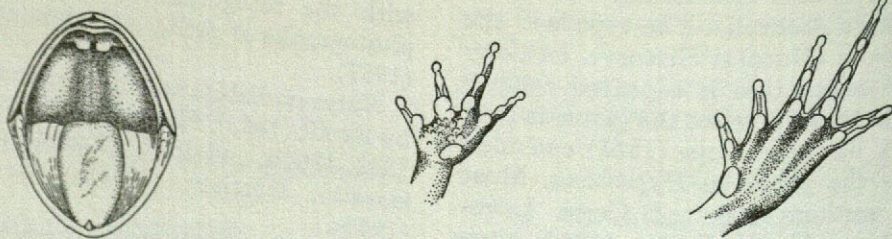


FIG. 30. *Crinia haswelli*. Open mouth, hand, and foot. A.M.N.H. No. 62237. National Park, Botany Bay, New South Wales.

rushes at the edge of the water of this coastal swamp.

The second locality was along Prince's Highway about 5 miles east of Cann River, Victoria. This was a grassy meadow with a number of small and shallow pools. The adults were at the edge of the pools and well hidden in the grass. The date was February 18, 1953.

The third locality was a grassy marsh in National Park, Botany Bay, New South Wales. The water was 3 to 6 inches in depth, with a mat of dead sedges on the surface. Three males were calling, two from under the mat and one on the mat. The date was March 17, 1953.

I did not collect any breeding pairs and have no information on embryonic development.

VOICE

The call is a short and definite "wronk," with emphasis on the "nk." The duration is about half a second. At a distance it has a metallic sound, reminding one somewhat of a bell-bird. When nearby the sound is more nasal.

GEOGRAPHIC DISTRIBUTION

Crinia haswelli is a coastal plain species. Its known range is from Ocean Beach (near Woy Woy), New South Wales, to 5 miles east of Cann River, Victoria (fig. 31). The type locality is "near the head of Jervis Bay."

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Maroubra Bay (Nos. 4210, 5288, 6132-6135)

Illawarra (No. 6975)

Jervis Bay (No. 10335; four specimens; type series).

The American Museum of Natural History has specimens from:

Ettymalong Swamp, Ocean Beach, near Woy Woy (No. 62238)

National Park (Nos. 62235-62237)

VICTORIA RECORDS

The American museum of Natural History has specimens from:

5 miles east of Cann River (Nos. 62229-62234)

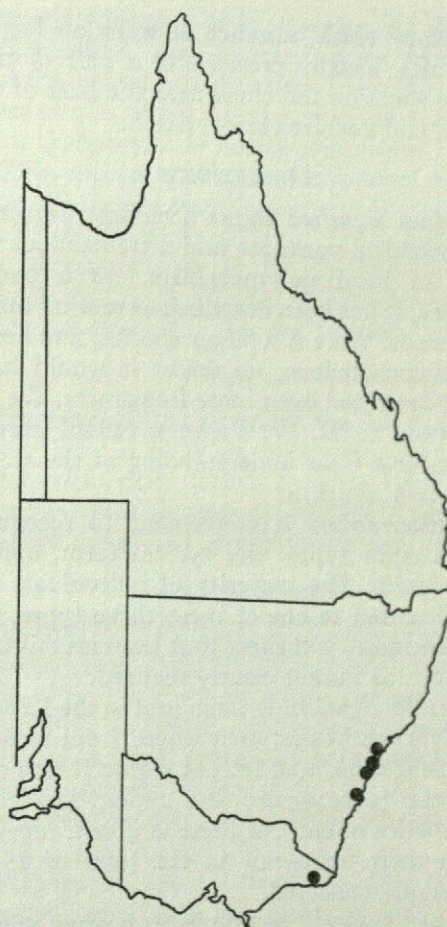


FIG. 31. *Crinia haswelli*. Geographic distribution.

LITERATURE

Very little has been published about *Crinia haswelli*. It was described by Fletcher (1894a). The cotypes are in the Australian Museum. Other descriptions are given by Lucas and Le Souëf (1909), Nieden (1923), and H. W. Parker (1940).

The species is mentioned by Fletcher (1894b), Fry (1914), Roux (1920), and Chisholm (1925).

Crinia signifera Girard

THE COMMON FROGLET

Plate 39, figures 4, 5; text figure 32

DIAGNOSIS

Crinia signifera can be distinguished from other eastern New South Wales frogs by its small size (body length usually less than 25 mm.), absence of vomerine teeth, presence of

maxillary teeth, absence of webs on fingers and toes, usually presence of a pair of tiny white spots on the chest near the base of the arms, and a white cloacal patch.

DESCRIPTION

Crinia signifera shows a modest degree of geographical variation and a tremendous degree of local polymorphism. As a consequence, it has been described as new on many occasions. Were it a larger species, and hence more conspicuous, no doubt it would have been described even more frequently. We are indebted to H. W. Parker's (1940) careful work for a clear understanding of the status of *Crinia signifera*.

Parker found it convenient to recognize three main types: the typical form, *affinis*, and *ignita*. The majority of individuals can be allocated to one of these three types, but a close study will show that the variability is greater, as Parker clearly realized.

Crinia signifera is abundant in the Killara, New South Wales, area where I did most of my field work, and in that region it was convenient to recognize five types. The characteristics of each of these is given, together with their frequency in the total of 85 individuals collected.

The "typical" morph is drab when viewed from above. The predominant color is a grayish brown. The background tends to be somewhat lighter, with irregular darker spots. In many specimens there is a V-shaped bar between the eyes, with the free ends of the V reaching the eyes and its point projecting posteriorly. There is usually a small wart or short skin ridge associated with each spot. The arrangement of these skin elevations is very irregular. The typical form, then, is characterized by an irregular arrangement of the spots and warts, as shown in the female (pl. 39, fig. 4). At Killara the frequency is 33 per cent.

The "atypical" form differs from the typical in lacking the spots on the back. It is therefore fairly uniform in the coloration of the dorsal surface. There are numerous small warts, which may be arranged in irregular longitudinal rows, and give the skin a rough appearance. The typical and atypical forms intergrade completely. The frequency of the atypical form is 14 per cent. Parker's typical

form includes my typical and atypical subdivisions, and their combined frequency at Killara is 47 per cent.

The "*ignita*" morph is characterized by longitudinal stripes and skin folds. The male shown in plate 39, figure 4, is of this type. There is a broad brownish band on the dorsal side that extends from the snout to the cloaca. This band is cut by a light, V-shaped patch that begins with the open ends of the V at the eyes and projects posteriorly. In some individuals a narrow, dorsal stripe, which is in the middle of the broad brown band, extends from the point of the V to the cloaca. There is a light stripe on each side of the broad, dark, central stripe, and lateral to each of these is usually a dark stripe. This dark stripe, which is on the side of the body, is divided into an anterior and posterior portion. The anterior portion extends from the snout to the eye and from the eye posteriorly and ventrally towards the base of the arm. The posterior portion extends horizontally along the sides from the level of the arm to the groin. (The typical form usually has these dark lateral stripes poorly developed, and in the atypical form they are even less developed.) The skin of the *ignita* type has a series of spots or longitudinal skin folds, restricted to the dark central stripe. The frequency of the *ignita* type at Killara is 25 per cent.

The "*affinis*" type is like *ignita* but without the dark central stripe and warts. The entire dorsal surface is nearly always smooth and uniformly colored, varying from a dark grayish brown to an attractive tan. On each side there is usually a dark lateral stripe, as in the *ignita* type. The frequency of the *affinis* type at Killara is 19 per cent.

There are so many intergrades between the *affinis* and *ignita* types that they are classed as a fifth type, the "*affinis-ignita*" intergrades. These are like *affinis* but have a faint suggestion of the dark midline stripe of *ignita* and usually a few warts or longitudinal skin folds. The frequency of this category is 9 per cent at Killara.

The ventral surface of *Crinia signifera* is subject to as much color variation as the dorsal surface. The patterns of the dorsal and ventral sides, however, vary independently. The ventral surface may be fairly uniform, either dusky or black, with tiny white spots.

At the other extreme it may be nearly white, with a few irregular dark patches. Between these two extremes there are many individuals having the ventral side as boldly marked as many of the species of *Pseudophryne* (pl. 40).

Two markings seem to be constant in this highly variable species. First, there is a pale patch at the cloacal opening. Second, there is a tiny white spot on the ventral side at the base of each arm. These pectoral spots are conspicuous in individuals that are dark underneath but less conspicuous in paler individuals.

As far as the texture of the skin is concerned, that of the dorsal surface is discussed above. The skin of the ventral side anterior to the pectoral girdle is smooth but granular posteriorly.

Crinia signifera is a small frog of average proportions. Measurements were made of 10 males and 10 females that were collected as clasping pairs at Killara, New South Wales. The males vary from 18.9 to 22.8 mm. in body length, and their body proportion ratios are: tibia length/body length, 0.44 ± 0.01 (0.40–0.48); head length/body length, 0.32 ± 0.01 (0.28–0.35); head width/head length, 1.01 ± 0.01 (0.97–1.06). The females vary from 22.3 to 26.6 mm., and their ratios are: tibia length/body length, 0.41 ± 0.01 (0.37–0.45); head length/body length, 0.30 ± 0.00 (0.28–0.33); head width/head length, 1.01 ± 0.01 (0.99–1.07). The largest individual that I have seen has a body length of 29 mm. (Australian Museum No. 12329). It is from Cox Bight, Tasmania. H. W. Parker (1940) gives the maximum size as 30 mm.

The tympanic membrane is scarcely visible.

The fingers are not webbed. The length sequence is $3 > 4 = 2 > 1$. There are prominent tubercles on the fingers.

The toes are not webbed, but they have well-developed lateral fringes. There are a small inner and a smaller outer metatarsal tubercle.

There are no vomerine teeth. The tongue is narrow.

HABITAT

Although *Crinia signifera* is an aquatic species, it has a very liberal interpretation of

what constitutes a body of water. At Killara males called, and clasping pairs bred, in puddles containing no more than 100 milliliters of rain water. During a period of heavy rain, therefore, it is nearly ubiquitous.

This species was also encountered in the coastal marshes near Sydney, ponds (pl. 29, fig. 1), lakes, wet meadows, alpine lakes on Mt. Kosciusko (pl. 31, fig. 2), and streams (pl. 28, fig. 1; pl. 32, fig. 2). It also occurs along the streams of the dry interior.

VOICE

Harrison (1922) describes the voice as follows: "The note is an insect-like chirrup—'crick-crick-crick,' which becomes double in chorus—'crick-ik, crick-ik, crick-ik.' " Such is the way the species sounds to me also.

BREEDING HABITS

At Killara, New South Wales, breeding was observed from July 25, 1952, to February 7, 1953. The extremes of water temperatures were 11° C. and 21° C. The eggs are deposited singly or in small groups on rocks, sticks, or exposed rootlets of plants (pl. 39, fig. 5) in tiny pools, puddles, or streams. Amplexus is pelvic in position (pl. 39, fig. 4).

Perhaps the most interesting thing that I observed was that, in spite of the large amount of breeding that occurred, no transforming young were ever encountered. Eggs were deposited in puddles that were dry within a few days. The mortality was truly prodigious, and it is difficult to understand how the species can be so abundant. No doubt it broadcasts its embryos in innumerable bodies of water, and for a few of these development to the juvenile stage must actually occur.

Special attention was paid to the types of individuals that were found in clasping pairs, as at one time or another the polymorphs have been regarded as separate species. The data for 22 clasping pairs, collected at Killara, are given in table 1. In only three pairs were both individuals the same. Obviously, there is a large amount of crossing between individuals of the various types, but the data are not voluminous enough for one to say that the combinations are wholly at random. It will be noticed also that there are sex differences in this sample. For example, there

TABLE 1

TYPES OF INDIVIDUALS IN TWENTY-TWO CLASP-
ING PAIRS OF A POPULATION OF *Crinia signi-*
nifera, FROM KILLARA, NEW SOUTH WALES

Female	Male
Typical	Typical
Typical	Typical
Typical	<i>ignita</i>
Typical	<i>ignita</i>
Typical	<i>affinis</i>
Typical	<i>affinis-ignita</i>
Atypical	Typical
Atypical	Typical
Atypical	<i>affinis</i>
Atypical	<i>affinis</i>
<i>affinis</i>	<i>affinis</i>
<i>affinis</i>	<i>ignita</i>
<i>affinis</i>	<i>ignita</i>
<i>affinis</i>	<i>ignita</i>
<i>affinis</i>	Typical
<i>affinis-ignita</i>	Atypical
<i>affinis-ignita</i>	Typical
<i>affinis-ignita</i>	Typical
<i>affinis-ignita</i>	<i>ignita</i>
<i>ignita</i>	<i>ignita</i>
	Typical

is only one female of the *ignita* type, but one-third of the males were *ignita*. These differences may be due to errors in sampling.

Fletcher (1889) observed breeding in June at Burrawang, July (?) at Capertee, December at Mt. Wilson, and February, May, and July near Sydney, all in New South Wales.

Harrison (1922) remarks on the great variety of breeding sites and on the type of egg. He found that a female produces about 150 eggs.

SIBLING SPECIES

As understood by H. W. Parker (1940), *Crinia signifera* consists of a single species that is widely distributed in Australia, occurring in all areas except the most arid. The populations of Tasmania and the Kosciusko area were described as subspecies, *Crinia signifera englishi* and *Crinia signifera montana*, respectively. A point to be emphasized is that the populations of eastern and western Australia were thought to be the same. In Tasmania there is a closely similar species,

Crinia tasmaniensis. Other species that Parker recognized as occurring in eastern Australia, but not closely similar to *Crinia signifera*, are *Crinia laevis* (Victoria and Tasmania), *Crinia darlingtoni* (known only from the type locality in southern Queensland), *Crinia haswelli* (Victoria and New South Wales), and *Crinia acutirostris* (Queensland). In the southwest corner of Western Australia Parker recognized, in addition to *Crinia signifera*, the following: *Crinia leai*, *Crinia rosea*, *Crinia georgiana*, and, somewhat hesitantly, *Crinia glauerti*.

With the material available and the methods used, it would be difficult to improve Parker's classification. When additional methods are employed, however, it becomes clear that the species he recognized do not always correspond with the natural species groups. In the case of *Crinia signifera* the matter is becoming exceedingly complex.

The first indications of this complexity were seen in the results of crosses of eastern and western "*Crinia signifera*" (Moore, 1954a). When individuals from Killara, New South Wales, and Attadale (not Armadale as stated in the paper; the two localities are about 12 miles apart), Western Australia, are crossed, the hybrids exhibit a degree of defectiveness that makes it necessary to regard them as separate species. The Attadale individuals were named *Crinia insignifera*.

These investigations were only the first of a series that have revealed *Crinia signifera* to be a group of populations with complex interrelations. Main and his associates have combined the methods of cross fertilization, analysis of call structure, and detailed field observations in these investigations.

Main (1957a) repeated the cross of a New South Wales (East Lindfield, a few miles from Killara) female and an Attadale, Western Australia, male and obtained no normal embryos, thus confirming the validity of *Crinia insignifera*. Field work showed that it was restricted to coastal areas (fig. 32).

Crinia insignifera was not the only unrecognized species in Western Australia. To the east it is replaced by a population that is morphologically similar, but the males have a different call, which is a "baa, baa, baa" instead of the harsh squelching call of *Crinia insignifera*. Because of the difference between

these populations in their calls, Main has named the more inland population *Crinia pseudinsignifera*.

Crosses were made between *Crinia insignifera* and *Crinia pseudinsignifera*, but the results were equivocal. The percentage of embryos that hatched varied, but there was no consistent evidence of defective development. The main reason for recognizing the species, therefore, is the fact that the male call is very different from that of *Crinia insignifera*, and in this character there is no intergradation.

In this same paper Main described a new species of the *Crinia signifera* group from eastern Australia. In the Murray River Valley (fig. 32) he encountered some males with calls and morphology indistinguishable from those of the western *Crinia insignifera*. These were given a new name, *Crinia parinsignifera*. Crosses of *Crinia parinsignifera* with *Crinia signifera* and of *Crinia parinsignifera* with *Crinia insignifera* resulted in a high degree of hybrid inviability. In some localities *Crinia signifera* and *Crinia parinsignifera* are sympatric.

Finally, the status of *Crinia glauerti* was settled. Main (1957a) finds it a valid species, which is partly sympatric with *Crinia insignifera* and *Crinia pseudinsignifera*. In some respects it resembles *Crinia signifera* from eastern Australia more than any of the western Australian species.

Another sibling species from Western Australia was described by Littlejohn (1957) as *Crinia subinsignifera*. In morphology it is indistinguishable from *Crinia insignifera* and *Crinia pseudinsignifera*. The call of the males is unique, though resembling that of *Crinia insignifera*. Crosses of *Crinia subinsignifera* with *Crinia insignifera* and of *Crinia subinsignifera* with *Crinia pseudinsignifera* are said to show reduced larval viability. This is not apparent, however, from the data presented. No defects in development are mentioned. The only measure of viability is the percentage of the initial number of "eggs" that hatch. The data show the per cent hatching in four experimental groups to be 61, 68, 29, and 92 compared to 84, 89, 96, and 96 for the controls. It is not stated whether the initial number of "eggs" refers to the total of all eggs or only to those that are fertilized.

Therefore the lower values for the experimental groups may signify that a lower percentage of the eggs were fertilized or that fewer embryos reached the hatching stage. A lower percentage of fertilization is not significant in work of this sort, whereas reduced embryonic viability is.

The known range of *Crinia subinsignifera* is entirely within the range of *Crinia pseudinsignifera*, but it is allopatric with *Crinia insignifera* (fig. 32).

More recently another species, *Crinia sloanei*, was described from the Murray Valley in eastern Australia (Littlejohn, 1958). Once again, it was the unique call of the male that drew attention to the new species. In several places it occurs with the other eastern species, *Crinia signifera* and *Crinia parinsignifera*. Careful study showed that the three differ slightly in morphological characteristics and considerably in call structure.

Clearly the populations formerly referred to as *Crinia signifera* present extraordinarily interesting problems in systematics and evolution. The conventional tools of herpetology are of little use alone in the study of these problems. Supplementary information must be obtained by cross fertilization, analysis of call structure of the males, and field studies. The difficulties are great enough even for persons able to study the animals in nature; they are almost insurmountable for those who have only preserved material with which to work.

Rabb and Mosimann (1956) have protested against the practice of describing species on the basis of the data of cross fertilization when there are apparently no morphological differences. I do not agree with their point of view (see Moore, 1956). An important principle is involved: basically it is whether one is concerned with the "species" that are produced by taxonomists or the "species" that are produced by evolution.

It might be added that the original objection of Rabb and Mosimann was based on the apparent morphological identity of *Crinia signifera* and *Crinia insignifera*. The objection is no longer valid. Main (1957a) finds that *Crinia insignifera* and *Crinia signifera* do differ very slightly in pigmentation. There still remain, however, other sibling species of *Crinia* that seem to be

morphologically identical. One example is *Crinia insignifera* and *Crinia parinsignifera* (Main, 1957a). In addition, Littlejohn (1957) finds it impossible to distinguish *Crinia subinsignifera* from *Crinia insignifera* or *Crinia pseudinsignifera* on morphological grounds.

One should not conclude, with the splitting off of *Crinia insignifera*, *Crinia pseudinsignifera*, *Crinia sloanei*, *Crinia subinsignifera*, and *Crinia parinsignifera*, that the residue of "*Crinia signifera*" is homogeneous. Only a small portion of the range has been studied. Undoubtedly the complexity is far greater than is currently realized.

It should be mentioned in passing that when crosses are made between individuals that are *Crinia signifera signifera* and *Crinia signifera montana*, as well as between *Crinia signifera signifera* and *Crinia signifera englishi*, according to H. W. Parker's (1940) classification, the resulting embryos are normal (Moore, 1954a).

EMBRYONIC DEVELOPMENT

Numerous groups of embryos of *Crinia signifera*, from both natural and artificial fertilizations, were studied. All were from Killara, New South Wales.

The ova vary from 1.4 to 1.6 mm. in diameter. The animal hemisphere is very dark brown, and the vegetal hemisphere is light (pl. 39, fig. 5). The time required for various stages to be reached, at approximately 15° C., is as follows: stage 10, 26 hours; stage 12, 36 hours; stage 14, 50 hours; stage 16, 67 hours; stage 17, 74 hours; stage 18, 115 hours; and stage 19, 130 hours. The notes that follow are for embryos developing at approximately 15° C.

The cleavage, blastular, and gastrular stages are not notably different from the "typical" frog pattern. In a stage-16 embryo the posterior part of the neural fold area, which will form the tail bud, is considerably more massive than the anterior end. The stomodaeum begins to form at this time. The outgrowth of the tail bud is in a dorsal rather than in a posterior direction. It does not straighten out until stage 19. The T-shaped glandular area on the head, described above for *Uperoleia marmorata*, is present in *Crinia signifera*.

There are no external gills. An operculum

forms but, from a study of externals alone, I am not sure how it is accomplished. The events are as follows: In the 6-mm. embryo a depression, which projects inward and anteriorly, forms at the posterior edge of each gill plate. By the time the embryo has a length of 7.5 mm. the depressions have become slits, which move towards the ventral midline. Either these slits unite, or the right one closes, for in the 8-mm. embryo only the left one remains. I believe this becomes the spiracle, but I am not sure.

The embryos, if undisturbed, remain in the jelly for at least 10 days and hatch as well-formed tadpoles.

The 22-mm. tadpole has a subterminal mouth that opens ventrally. There are two complete rows of teeth anterior to the mouth and two long and one short row behind. The tadpole is fairly light in color. On the dorsal side there are numerous golden chromatophores but few melanophores, except on the snout. The skin of the abdominal region is transparent, and the loops of the intestine are clearly visible. Melanophores are numerous in the region of the opercular cavities. There are large black spots in the myotome region and in the dorsal fin of the tail. There are very few melanophores in the ventral tail fin. The spiracle opens to the left and the anus to the right.

The maximum tadpole size is about 31 mm. Approximately six weeks are required for the interval between the beginning of development and transformation in the laboratory at approximately 15° C. The body length of the juvenile is 8.3 mm.

GEOGRAPHIC DISTRIBUTION

After the discussion of the sibling species of the *Crinia signifera* group, it should be apparent that it is impossible to delimit the range of *Crinia signifera* with any confidence of ultimate accuracy. Nevertheless, it does seem worth while to plot the distribution of the frogs that are morphologically similar to *Crinia signifera*. This has been done in figure 32.

This figure also shows the known ranges, which are obviously incomplete for all but the southwest, of the sibling species. For this information I have relied on Main (1957a) and Littlejohn (1957, 1958). No attempt has

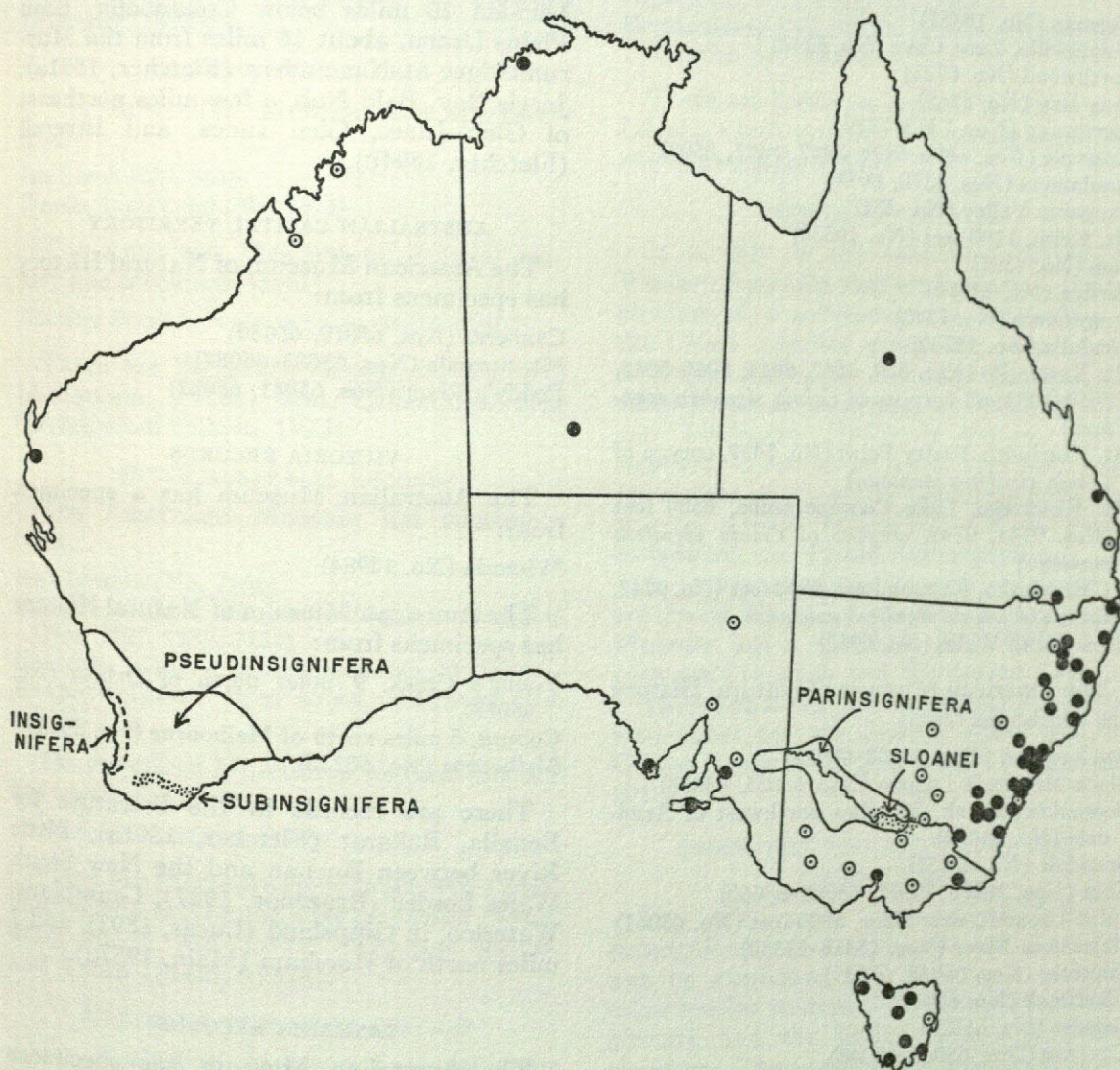


FIG. 32. *Crinia signifera* and allied species. Geographic distribution.

been made to indicate specific localities within the ranges of the sibling species.

Crinia signifera, broadly interpreted, occurs over much of Australia. It is also known from Merauke in southern New Guinea (Roux, 1920; H. W. Parker, 1940).

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Tweed River (Nos. 6490, 8490)
Hoonbrook (No. 11868)
Nambucca River (Nos. 5888-5892)
Warrell Creek, Nambucca River (Nos. 4250, 4628, 4629)

Gurravembi, Nambucca River (Nos. 6304-6306)
Tamworth (No. 4764)
Comboyne (No. 11383)
Barrington Tops (Nos. 13307, 13355)
Myall Lakes (No. 7918)
Avoca, near Gosford (No. 6500)
Upper Colo, via [near] Richmond (No. 7977)
Lowther district (No. 13394)
Megalong Valley, Katoomba (No. 5210)
Woodford, Blue Mountains (No. 4352)
Lindfield (Nos. 4109, 4186, 4327-4329, 4364, 4397-4399)
Maroubra Bay (Nos. 4209, 8085, 8303, 8321, 10562, 10563)
Smithfield (No. 2879)
Rose Bay (No. 9835)

- Mosman (No. 10351)
 Longueville, Lane Cove (No. 8242)
 Northwood (No. 8725)
 Long Bay (No. 8765)
 Burrawang (Nos. 7378-7380)
 Mossvale (Nos. 6496-6498, 8487, 8497, 8502)
 Bundanoon (Nos. 4370, 8638)
 Kangaroo Valley (No. 204)
 Mt. Keira, 1100 feet (No. 10530)
 Yass (No. 7397)
 Nerriga (No. 12276)
 Bungendore (No. 7328)
 Ulladulla (No. 12280)
 Mt. Kosciusko (Nos. 579, 4647, 5044, 5046-5048, 5050-5053; all cotypes of *Crinia signifera montana*)
 Mt. Kosciusko, Pretty Point (No. 7439, cotype of *Crinia signifera montana*)
 Mt. Kosciusko, Lake Cootapatamba, 6500 feet (Nos. 9741, 9743, cotypes of *Crinia signifera montana*)
 Mt. Kosciusko, Rawson Pass, 6800 feet (No. 9742, cotype of *Crinia signifera montana*)
 *New South Wales (No. 6953)

The American Museum of Natural History has specimens from:

- Ben Lomond (Nos. 65050-65054)
 Black Mountain Lagoon (Nos. 65055, 65056)
 Booroolong Creek, 20 miles northwest of Armidale (No. 65049)
 Armidale (No. 65057)
 Ebor (Nos. 20070-20077, 65058-65060)
 Point Lookout, near Ebor, 5000 feet (No. 65061)
 Nambucca River (Nos. 13328-13330)
 Capertee (Nos. 65038, 65039)
 Glenbrook (No. 65037)
 Galston (No. 65026)
 Clarence (Nos. 65043-65048)
 Lindfield (Nos. 13331, 13332)
 Killara (Nos. 64939-65024)
 Bundeena (Nos. 65035, 65036)
 Mosman (No. 65025)
 National Park (Nos. 65027-65034)
 Bulli Nos. 65062, 65063)
 Burradoo (Nos. 65040-65042)
 Gerroa (Nos. 65070, 65071)
 Albury (No. 65064)
 Lawler's Creek, Bodalla (No. 65072)
 Mt. Kosciusko, Betts Creek (Nos. 65066, 65067)
 Mt. Kosciusko, Lake Albina (Nos. 65068, 65069)
 Mt. Kosciusko (Nos. 13331, 13332, 65065)

There are records in the literature for Mt. Wilson (Fletcher, 1889), Nundle on the Naomi, Guntawang near Mudgee, Mulwala on the Murray (not shown in fig. 32), Wagga (Fletcher, 1890), Kiacatoo Station on the

Lachlan 20 miles below Condobolin, Emu Plains Urana, about 18 miles from the Murrumbidgee at Narrandera (Fletcher, 1891a), Jervis Bay, Bald Nob, a few miles northeast of Glen Innes, Glen Innes, and Inverell (Fletcher, 1894b).

AUSTRALIAN CAPITAL TERRITORY

The American Museum of Natural History has specimens from:

- Canberra (Nos. 65079, 65080)
 Mt. Stromlo (Nos. 65083-65087)
 Paddy's River (Nos. 65081, 65082)

VICTORIA RECORDS

The Australian Museum has a specimen from:

- *Victoria (No. 12984)

The American Museum of Natural History has specimens from:

- Young's Creek, 9 miles north of Orbost (No. 65078)
 Coburg, 5 miles north of Melbourne (No. 50235)
 Melbourne (No. 50236)

There are records in the literature for Benalla, Ballarat (Fletcher, 1891a), Little River between Buchan and the New South Wales border (Brazenor, 1947), Grampians, Waterloo, in Gippsland (Lucas, 1892), and 7 miles north of Horsham (Main, 1957a).

TASMANIA RECORDS

The Australian Museum has specimens from:

- Ulverstone (No. 7601, cotype of *Crinia signifera englishi*; No. 7602)
 Launceston (Nos. 6041-6045; cotypes of *Crinia signifera englishi*)
 Lake St. Clair (Nos. 12123, 12124)
 National Park (Nos. 10356, 10357, cotypes of *Crinia signifera englishi*)
 Eagle Hawk Neck (No. 10353, cotype of *Crinia signifera englishi*)
 Cox's Bight, southwest Tasmania (No. 12329)

The American Museum of Natural History has specimens from:

- Arthur River (Nos. 40289-40302)
 Lake St. Clair (Nos. 65088-65097)
 Derwent Bridge (Nos. 65124-65130)
 *Tasmania (No. 24004)

There is a literature record for Swansea (Fletcher, 1898).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Isis Scrub (No. 8636)

Waroo, Inglewood (No. 7413)

The American Museum of Natural History has specimens from:

Rainsby Station, Aramac (Nos. 65073-65077)

There are literature records for Yandina (Andersson, 1913a) and Callandoon near Goondiwindi (Slevin, 1955).

SOUTH AUSTRALIA RECORDS

The Australian Museum has specimens from:

Port Lincoln (No. 7168)

Kangaroo Island, Birchmore Lagoon, Kingscote (Nos. 7127, 7132, 7133)

Kangaroo Island, Timber Creek (No. 7151)

Kangaroo Island, Deep Creek, Kingscote (No. 7161)

The American Museum of Natural History has specimens from:

Adelaide (Nos. 23596, 23597)

There are literature records for Mt. Lyndhurst which is 20 miles east of Farina (Kinghorn, 1924), Mt. Lofty, *Flinders Range, and Truro (Main, 1957a).

NORTHERN TERRITORY RECORDS

The Australian Museum has specimens from:

Darwin area (No. 12898; two juveniles; identification not certain)

Night Cliff, Pt. Darwin (No. 10084)

Hermansburg (No. 10977; faded specimen; identification not certain)

There are literature records for Knuckey's Lagoon which is about 9 miles south of Darwin (Loveridge, 1949).

WESTERN AUSTRALIA

It is only in the southwest portion of Western Australia that we have even the beginnings of a satisfactory understanding of the *Crinia signifera* group. No locality records are entered on the map. Instead, the distribution as described by Main (1957a) and Littlejohn (1957) is shown. *Crinia signifera*, in the strict sense, does not occur. Its closest relatives are *Crinia glauerti* (not shown), *Crinia insignifera*, *Crinia pseud-insignifera*, and *Crinia subinsignifera*.

A *Crinia signifera*-like species occurs in northwest Western Australia. The Australian Museum has a specimen (No. 9780) from between Carnarvon and Northwest Cape.

There are literature records for the northwest coast for the Fitzroy River and St. George Range in the Kimberleys (Andersson, 1913a).

GEOGRAPHIC DISTRIBUTION OF THE COLOR TYPES

The various color types referred to in the description are widely distributed. (It might also be mentioned that they even occur in other species, such as *Crinia georgiana*, *Crinia glauerti*, and the sibling species of *Crinia signifera*.) The pattern of distribution is not random. In table 2 the percentages found in six localities are given. The specimens from the Nambucca River, Mt. Kosciusko, Ade-

TABLE 2
GEOGRAPHIC VARIATION IN THE COLOR PATTERNS OF *Crinia signifera*

Locality	Sample Size	Frequency in Per Cent				
		Typical	Atypical	<i>ignita</i>	<i>affinis</i>	<i>affinis-ignita</i>
Rainsby Station, Queensland	17	100	0	0	0	0
Nambucca River, New South Wales	39	10	0	26	59	5
Port Stephens, New South Wales	72	28	7	33	31	1
Killara, New South Wales	85	33	14	25	19	9
Mt. Kosciusko, New South Wales	28	7	0	96	0	0
Adelaide, South Australia	42	31	0	36	33	0

laide, and Kangaroo Island are in the Australian Museum. Those from Killara and Rainsby Station are in the American Museum of Natural History, and those from Port Stephens are in the Macleay collection at Sydney University.

I have no explanations for these geographic differences, i.e., the dominance of the typical type of Rainsby Station, of the *affinis* type on the Nambucca River, or of the *ignita* type of Mt. Kosciusko. At the present I merely wish to call attention to these facts and to suggest that the results of a careful study of the geographical, seasonal, and yearly variations in the polymorphs of *Crinia signifera* would be of great importance for concepts in evolution and ecology.

COMMENTS

When we consider that *Crinia signifera* is the most common and widespread species in eastern New South Wales, it is difficult to understand why it remained unknown for so long. Apparently it was not secured by the early collectors. It was unknown to Duméril and Bibron (1841). In Günther's "Catalogue" (1858, p. 134) there is the notation "Many specimens. Van Diemen's Land. Presented by Sir A. Smith," under *Cystignathus georgianus*. I would have suspected these might have been *Crinia signifera* were it not for the fact that I cannot find a reference to these specimens by either Boulenger (1882) or H. W. Parker (1940). It seems doubtful, therefore, that Günther was familiar with *Crinia signifera* in 1858.

Possibly it was not collected because its small size suggested that it was only a juvenile of a large species. A second possibility is that its present abundance is a consequence of man's activities in altering the environment, which seems unlikely, however, for *Crinia signifera* is too widespread and is found in too many habitats.

LITERATURE

Crinia signifera was originally described as *Crinia* (*Ranidella*) *signifera* by Girard (1853). The type locality was New Holland. He suspected that it belonged to a new genus, *Ranidella*, but in the absence of examples of *Crinia*, he could not be sure. His description is of an individual of the *ignita* type. In 1858 he was surer of himself and, under the name

Ranidella signifera, gave a long description and illustrations of an adult of *ignita* type and of the head, hand, and foot.

Cope (1867) first used the name *Crinia signifera*.

Several species have been described as new that are now regarded as synonyms. *Pterophrynus verrucosus* was described by Lütken (1863, with a drawing of the adult). The type locality is Australia. The specimen shown in the illustration seems to be of the color pattern that I call "atypical." Günther (1868a) and Krefft (1870) referred to it as *Crinia verrucosa*.

Camariolius varius was described by Peters (1863) from Adelaide. Boulenger (1882) suggested that Peters might have had individuals of two species, *Crinia signifera* and *Crinia tasmaniensis*. Steindachner ("1869" [1867]) gives a description and illustrations of adults of the "typical" type, and of the open mouth, hand, and foot, using the name *Pterophrynus varius*. Krefft (1865) used this last name and later (1867) used *Pterophrynus varius*, a *lapsus calami*. Keferstein (1867) refers to it as *Crinia georgiana* var. *varia* (see also Günther, 1868b, who questions this) and, in 1868a, as *Crinia varia*, with two figures of the adults and one of the foot.

Crinia georgiana var. *laevipes* was described as new by Keferstein (1867) from Sydney.

Crinia stictiventris was described by Cope (1867) as a new species from Australia.

Pterophrynus fasciatus was described by Steindachner ("1869" [1867], with dorsal and ventral figures of an adult of the *ignita* type) from New South Wales. This was referred to by Günther (1867) as *Pterophryne fasciata* and by Günther (1868a) and Krefft (1870) as *Crinia fasciata*.

Loveridge's (1935) treatment of *Crinia signifera* is questionable. The names that he uses, together with H. W. Parker's (1940) subsequent identifications in parentheses, are: *Crinia signifera signifera* (= *Crinia signifera*); *Crinia signifera ignita* (= *Crinia georgiana*); *Crinia affinis affinis* (= *Crinia georgiana*); *Crinia affinis haswelli* (= *Crinia signifera*).

Crinia affinis halmaturina described by Condon (1941) from Flinders Chase, Kangaroo Island, South Australia, is probably the morphological species *Crinia signifera*.

The sibling species that have been delimited in the *Crinia signifera* complex on the basis of call structure of the males and cross fertilization experiments are: *Crinia insignifera* Moore (1954a) from Attadale (not Armadale as stated), Western Australia; *Crinia pseudinsignifera* Main (1957a) from Yorkrakine Rock near Tammin, Western Australia; *Crinia parinsignifera* Main (1957a) from Kingston-on-Murray, South Australia; *Crinia subinsignifera* Littlejohn (1957) from Wilgarup, Western Australia; and *Crinia sloanei* Littlejohn (1958) from Murray River near Tocumwal, New South Wales.

Other descriptions of *Crinia signifera* are given by Boulenger (1882), Lucas and Le Souëf (1909, with a photograph of an adult), English (1910, with two colored illustrations of the adult), Andersson (1913a, with illustrations of the variations in color pattern), Roux (1920, New Guinea specimens), van Kampen (1923, New Guinea specimens), Nieden (1923), Lord and Scott (1924), Waite (1929), H. W. Parker (1940, describing as new *Crinia signifera englishi* from Tasmania and *Crinia signifera montana* from Mt. Kosciusko), Slevin (1955, with a photograph of an *ignita* type of adult), and Moore (1957a).

References concerned with the sibling species formerly included in *Crinia signifera* are Moore (1954a, 1954b, 1955, 1956, 1957b), Main (1957a), Main, Lee, and Littlejohn (1958), Littlejohn (1957, 1958), and Rabb and Mosimann (1956).

References that consist primarily of data on distribution are Fletcher (1890, 1891a, 1892, 1894b, 1898), Lucas (1892, 1897), English (1910), Kinghorn (1924), Blanchard (1929), Loveridge (1934, 1949), and Brazenor (1947).

The habits of *Crinia signifera* are discussed by Fletcher (1889), Ross (1908a), and Harrison (1922). Oeser (1934) and Klingelhöffer (1956) discuss the habits of captive individuals.

The hyoid and larynx are described by Trewavas (1933); the urinogenital organs, by Sweet (1908); the pigmentation of the ova, by Harrison (1921); the trematode parasites, by Johnston (1912); and *Batrachomyia* parasites by Krefft (1864, as *Cystignathus sydneyensis*).

There are minor references to this species in Boettger (1892), Aflalo (1896), Smith

(1929), Scott (1942), Barrett (1943), Loveridge (1945), and Main (1954c).

References to "*Crinia signifera*" from the southwest part of Western Australia that should now be listed for other species are Fry (1914), Werner (1914), Glauert (1929, 1945), Taylor (1935), and Main (1954a).

Pseudophryne australis (Gray)

THE RED-CROWNED TOADLET OR THE
HAWKSURRY TOADLET

Plate 40, figures 1-3, 7; text figures 33, 34

DIAGNOSIS

Pseudophryne australis is easily identified by its small size (body length usually less than 25 mm.) and the presence of a red patch on the top of the head.

DESCRIPTION

The background color of the dorsal surface is a very dark brown. On the dorsal side there are some red spots and patches. The most characteristic is a broad, T-shaped patch on the head. It includes the upper eyelids, the space between them, and a median stripe that extends to the tip of the snout. In addition to this crown patch, there is usually a broad stripe or spot of red over the urostyle. Frequently small red spots are scattered irregularly over the back. Other areas are whitish, namely, a spot on the posteroventral surface of the thigh near its distal end, a spot on the anteriodorsal surface of the thigh near the proximal end, and a band on the dorsal and posterior surfaces of the arm at its proximal end.

The ventral side is very dark brown, with large white or yellowish blotches. All in all, *Pseudophryne australis* is strikingly colored.

The skin is smooth, except for the ventral surface of the thighs and the posterior portion of the abdomen, which are granular. There is a glandular area on the posteroventral surface of the thigh near the distal end, which is nearly coextensive with the pale spot in this position.

Pseudophryne australis is a stocky and diminutive species. The largest male that I have seen has a body length of 24.6 mm. and the largest female is 25.3 mm. H. W. Parker (1940) reports the maximum size to be 27 mm. Seventeen adults from Killara, Kurrajong Heights, and National Park, New South

Wales, which have body lengths varying from 20.3 to 25.3 mm., have a mean tibia length/body length of 0.33 ± 0.00 (0.29–0.35). (The ratios involving head length are not given, as the standard method of determining this measurement is subject to large errors.)

There is no tympanic membrane. The canthus rostralis is rounded.

The ventral surface of the hand is dark, but the tips of the fingers and the well-developed tubercles are pale (fig. 33). There are two well-developed metacarpal tubercles. The fingers are not webbed. The sequence in length is $3 > 4 > 2 > 1$, the fourth finger being only slightly longer than the second. The fingers are rather stout and poorly developed.

There is no web between the toes, which are rather stout (fig. 33). The sole of the foot is dark, except for the tips of the toes and tubercles, which are pale. There are a small inner metatarsal tubercle and a smaller, almost invisible, outer metatarsal tubercle.

The tongue is narrow (fig. 33). There are neither vomerine nor maxillary teeth.

HABITAT

At Killara, New South Wales, *Pseudophryne australis* is common. The adults occur near tiny streams and pools. They are nearly always underground, beneath vegetation or in crevices in rocks, even at night.

Fletcher (1889) says that it is "very partial to damp shelves and cracks in the Hawkesbury sandstone."

Harrison (1922) observed a very interesting relation between the geology of the Sydney region and the distribution of *Pseudophryne australis* and its relative, *Pseudophryne bibroni*. To some extent he was anticipated by Krefft (1863). *Pseudophryne australis* is confined to the Hawkesbury sandstone and *Pseudophryne bibroni* to areas of

shale in the Sydney area. (The second species is widely distributed elsewhere.)

The Hawkesbury sandstone is a middle Triassic formation occupying most of the area bounded roughly by Sydney, Gosford, Wollombi, Denman, Rylstone, Lithgow, and Moss Vale, with the exception of a central area bounded roughly by Parramatta, Richmond, Penrith and Picton, which is Wianamatta (upper Triassic) shale.

My own observations, for the most part, confirm those of Harrison, but the following will show that the habitats of *Pseudophryne australis* and *Pseudophryne bibroni* are not always so distinct.

At Killara one of my favorite sites for studying *Pseudophryne australis* was a tiny temporary stream in the ditch along the St. Ives road. The species was found here in August and in the succeeding months until the middle of March. Then for a period of a month, which was very dry, the site was not visited. On April 13 and 14 there was rain, and on April 15 the site was checked. *Pseudophryne* males were calling, and with the removal of about an inch of mud, four nests were found, but the frogs with them were *Pseudophryne bibroni*. No *Pseudophryne australis* were found. Thus from August to March this one site was occupied by *Pseudophryne australis*, and no *Pseudophryne bibroni* were encountered here (and only one elsewhere near Killara). Yet during April (there were no further observations) it was occupied exclusively by *Pseudophryne bibroni*.

Clearly, a careful analysis of the microgeographic distribution and seasonal occurrence of *Pseudophryne australis* and *Pseudophryne bibroni* in the Cumberland Basin would be of great interest.

Distinctive faunas on the Hawkesbury sandstones and Wianamatta shales are known for other groups as well. Hindwood and Mc-

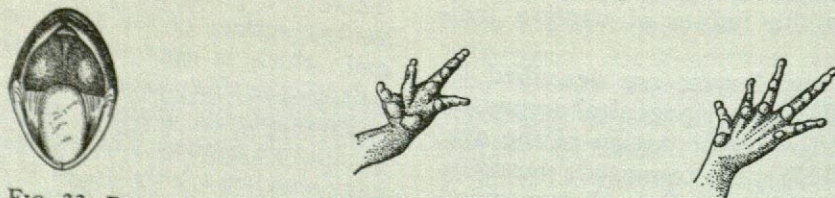


FIG. 33. *Pseudophryne australis*. Open mouth, hand, and foot. A.M.N.H. No. 65138. National Park, Botany Bay, New South Wales.

Gill (1958) report that "the Lyrebird, Pilot-bird, Rock-Warbler, Heath-Wren, Spotted Quail-Thrush, and others are characteristic of the sandstone and are not found on the Wianamatta Shales."

VOICE

The usual call of the male can be described as a nasal "ank-ank" or "ank" repeated slowly. Occasionally the call seems to be a short metallic "erk."

To Harrison (1922) the call is "a harsh, grating 'creek,' sometimes repeated twice or three times, and uttered by day as well as night, especially in the afternoons."

BREEDING HABITS

Males were first heard on August 3, just a few days after I began field work at Killara. They continued to call until March 12, but were not heard subsequently.

A clasping pair was taken at National Park, New South Wales, on August 18, brought to the laboratory, and the following morning there were 15 embryos. Claspings is in the pelvic position (pl. 40, fig. 1).

Young tadpoles were first noticed on the evening of October 14 at Killara in a pool where none had been on October 8. The water temperature was 17° C. and the air was 14° C. This pool was at the base of a cliff and held about 2 gallons of water. On November 9 the tadpoles were undergoing metamorphosis. Under these conditions, therefore, the time from egg to metamorphosis is about one month. Transforming young, from later spawnings, were also noticed here March 12 and April 15.

On November 9 a male was heard calling from a crevice about an inch wide in a rock. A tiny stone had dammed up about 25 milliliters of water in the crevice, and in this there were six small *Pseudophryne australis* tadpoles.

Some adults collected December 30 spawned in the laboratory on January 5.

Fletcher (1889) found ova in November, January, and May and a clasping pair in September. Harrison (1922) found eggs every month in the year.

Harrison (1922) has given a full and interesting account of the breeding habits of

Pseudophryne australis near Mosman. Eggs were found in nests in damp soil near the edge of a small pool. Each nest was about 1½ inches in diameter and ½ inch deep and covered by grass. Males and females were observed in empty nests, but nests with embryos had only the female or no adult. Later the embryos are washed into pools and complete their development. Harrison even suggests that the female may push the eggs from the nest into an adjacent pool "at what she considers the right time."

EMBRYONIC DEVELOPMENT

Two groups of eggs were laid in the laboratory by *Pseudophryne australis* collected at National Park, New South Wales (August 17, 1952), and Killara, New South Wales (December 30, 1952). The eggs are very large, the average diameters of the two groups being 2.6 and 2.7 mm. The diameter of the jelly envelopes is 6.6 mm. The ova are separate from one another, not united in a common jelly mass. The temperatures at which these embryos were raised were not constant, but they remained close to 14° C. for the first group, which are here described.

When the ova are first laid, there is a small cap of grayish brown pigment in the upper portion of the animal hemisphere. This pigmented area shifts before first cleavage, and its final position bears an important relation to the planes of cleavage and the polarity of the embryo. The uncleaved ovum has a spot near the equator that I believe indicates the entrance point of the sperm, but I have not substantiated this belief by a study of sectioned material. It is referred to as the equatorial spot. Shortly before first cleavage the animal-hemisphere pigment moves towards the equatorial spot and eventually occupies the half of the animal hemisphere above the equatorial spot. This migration is similar to that in *Rana*, which results in the formation of the gray crescent, but in *Pseudophryne australis* it is much more extensive. The plane of first cleavage is vertical and divides the pigmented zone into two equal portions and comes near the equatorial spot. The second cleavage plane is also vertical but at a right angle to the first. As a consequence, nearly all the animal-pole pig-

ment is restricted to the upper part of the two cells that are nearest to the equatorial spot. This unequal distribution of the pigment persists through the cleavage and blastular stages. Eventually the dorsal lip forms near the equator on the side of the embryo that is opposite the equatorial spot and the pigmented segment of the ovum.

These observations suggest that the classical relation between the entrance point of the sperm, the position of the gray crescent, the plane of first cleavage, and the position of the blastopore in the amphibian embryo is vividly obvious in *Pseudophryne australis*.

As might be expected in an egg of such size, the cleavage furrows form more slowly in the vegetal than in the animal hemisphere. The dorsal lip appears about 55 hours after first cleavage and is horizontal when first formed. Gastrulation is slow, and the blastopore is not complete until the embryo is 3.5 days old.

The neural folds are never elevated greatly above the surface of the embryo. When they have closed, the head end forms less of a protuberance than the posterior end. One week is required to reach stage 16. The embryo, when 10 days old, is 4.7 mm. in length. At this time the dorsal portion of the embryo is perched on the spherical yolk mass, reminding one of the embryos of many fish. There are about 11 myotomes, and the pronephros and its duct have formed.

There are no external gills. The operculum forms in much the same way as in *Crinia signifera*, beginning at about 15 days, when the embryo is 7 mm. in length. Two pits appear behind the gill plate which either fuse or the right one closes for, by 24 days, when the embryo is 11.5 mm. in length, only the left slit is present.

In the 11.5-mm. embryo the hind-limb buds have formed. The anus opens to the right side of the ventral tail fin. The suckers are always poorly developed. There are neither teeth nor jaws in the 11.5-mm. embryo. The teeth form after 29 days of development.

The embryos remain in the jelly for at least a month and hatch when they are about 17 mm. in length.

The tadpole reaches a maximum size of about 25 mm. The dorsal side of the body is

very dark, there being a continuous covering of melanophores with numerous small spots containing golden chromatophores. The ventral surface is also heavily pigmented, with only the skin of the median part of the abdomen being transparent. The myotome area of the tail is heavily pigmented, but there is little pigment in the tail fins. There are five rows of teeth, two in front of the mouth and three behind. The oral papillae are restricted to the sides and posterior border of the mouth.

Two months are required for development to the juvenile stage. The juveniles have a body length of 8 mm. The characteristic red patch of the head appears during metamorphosis.

Pseudophryne australis and *Crinia signifera* tadpoles are frequently found together at Killara. They can be distinguished as follows: To the eye, *Pseudophryne australis* is uniformly dark above and the tail transparent, but in *Crinia signifera* both the dorsal surface and the tail fins are mottled. The inner edge of the spiracle of *Crinia signifera* is free of the body wall, like the nozzle of a hose, but in *Pseudophryne australis* the inner side is fused to the body wall. The last row of teeth behind the mouth is nearly as long as the others in *Pseudophryne australis* but only half as long in *Crinia signifera*.

GEOGRAPHIC DISTRIBUTION

Pseudophryne australis has a small range, entirely in east-central New South Wales (fig. 34). Its known northern limit is Gosford and Kurrajong Heights, and it extends south to Burrawang. The western limits seem to be near Leura and Mt. Irvine. Within this area it is usually confined to the Hawkesbury sandstone. The type locality was originally given as Swan River, Australia. This is now assumed to be an error.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Gosford (No. 336)
- Mt. Irvine (No. 12924)
- Leura (No. 8467)
- Hazelbrook (No. 11091)
- Killara (Nos. 4591-4594)
- Lindfield (Nos. 4185, 4188)

French's Forest (No. 13423)
 Mosman's Bay (Nos. 4281-4288)
 Balmoral, Sydney (No. 2953)
 Sydney (No. 8466)
 Burrawang (No. 7377)

The American Museum of Natural History has specimens from:

Gosford (No. 6673)
 Kurrajong Heights (Nos. 65131, 65132)
 Hornsby (No. 23828)
 Killara (Nos. 13301, 13303, 13304, 13306-13310, 65141-65147)
 National Park (Nos. 65133-65140)

There are no literature records that extend the geographic range beyond that based on the specimens in the Australian Museum and the American Museum of Natural History.

LITERATURE

The endless confusion with respect to *Pseudophryne australis* is due in large part to what is surely an error made in specifying the type locality. Gray (1835) first described it, at a meeting of the Zoological Society of London, as *Bombinator australis*. The habitat was given by him as "in Australia," but the Secretary of the Society, or whoever was responsible for writing the minutes of the meeting, stated that the specimen was from the Swan River (sent by Joseph Wright). Later Gray (1841a) referred to his species as *Phryniscus australis* and indicated the locality as "New Holland." In 1845 he published an illustration of the adult, hand, and foot, using the name *Phryniscus australis*.

The "Swan River" is assumed to be the one in Western Australia. The type specimen of *Bombinator australis* is in the British Museum (Natural History), and H. W. Parker (1940) finds it to be conspecific with the red-headed *Pseudophryne* found only in the Sydney region. Parker states that "... there can be little doubt that the locality 'Swan River' is either erroneous or the less known river of the same name in New South Wales was intended." I would prefer that we take Parker's first suggestion, as I can find no lesser known "Swan River" in New South Wales. There are "Swan Bay" and "Swan Vale," both well outside the range of *Pseudophryne australis*, and "Swansea" on the periphery of the range.

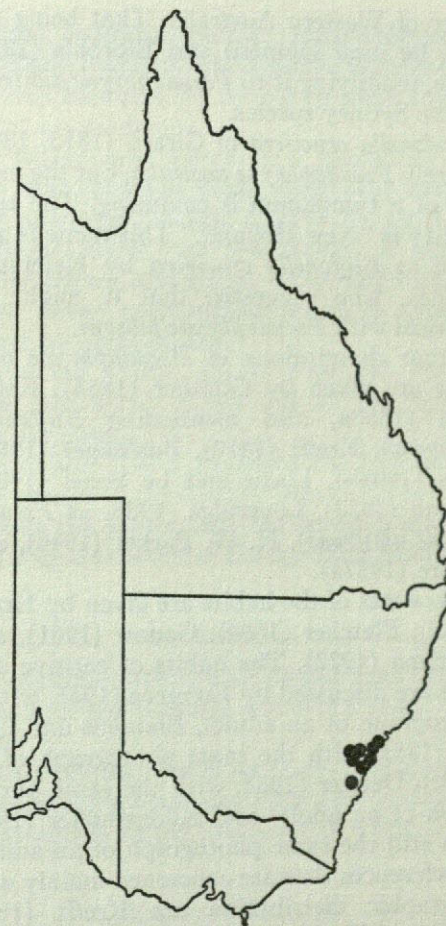


FIG. 34. *Pseudophryne australis*. Geographic distribution.

The name *Pseudophryne australis* was first used for this species by Günther (1858). Earlier, Fitzinger (1843) had used *Pseudophryne australis* as a new name for Duméril and Bibron's *Phryniscus australis*, which is *Pseudophryne bibroni* plus *Pseudophryne semimarmorata* according to H. W. Parker (1940).

Phryniscus albifrons was described by Duméril and Bibron (1854, with an illustration of the adult). No locality is given. There are specimens (Nos. 6268 and 6269) in the Muséum National d'Histoire Naturelle in Paris labeled "*Phrynisc. albifrons*. D. B. Australie. Castelnau." These are *Pseudophryne australis*. No indication is given on the label that these are types, however, and they are not so listed by Guibé [(1950?)].

Loveridge (1935) assumed that the type locality of *Bombinator australis* is the Swan

River of Western Australia. That being the case, he used Duméril and Bibron's (1854) name, modifying it to *Pseudophryne albifrons* for the Sydney species.

Bufonella crucifera of Girard (1853, 1858) is surely *Pseudophryne australis*, but the mention of a tympanum is confusing. The type locality is "New Holland." This name is also listed as *Buffonella crucigera* by Keferstein (1868a), who suggested that it might be identical with *Pseudophryne bibroni*.

Other descriptions of *Pseudophryne australis* are given by Günther (1858), Keferstein (1868a, also mentioning *Buffonella crucigera*), Krefft (1870), Boulenger (1882), Ross (1908b), Lucas and Le Souëf (1909), Nieden (1923), Loveridge (1935, as *Pseudophryne albifrons*), H. W. Parker (1940), and Moore (1957a).

Accounts of the habits are given by Krefft (1863), Fletcher (1889), Gadow (1901), and Harrison (1922). The habits of captive animals are discussed by Emmens (1955, with a photograph of an adult), Emmens and Gerber (1955, with the same photograph of an adult), Oertter (1955, with the same photograph of an adult) and Klingelhöffer (1956, with still the same photograph of an adult).

References that are concerned mainly with geographic distribution are Krefft (1865, 1867) and Fletcher (1890, 1894b, 1898).

The color of the ovum is described by Harrison (1921); the urinogenital organs are described by Sweet (1908), and the type of the ovum and tadpole is given by Balfour (1881).

Minor mention of the species is made by Fitzinger (1861), Anonymous (1883), Boettger (1892), Afalo (1896), Andersson (1913a, 1916), Smith (1929), Barrett (1943), and Kinghorn (1944, with a photograph of an adult).

Pseudophryne bibroni Günther

THE BROWN TOADLET

Plate 40, figures 6, 8, 9, 12, 13; text figure 35

DIAGNOSIS

This species can be distinguished from all others in eastern New South Wales by its small size (usually less than 30 mm. in body length), nearly uniform dark brown or black back (no red patch on the head), black and white marbled under parts, usually a yellow

spot at the base of the arm (but none on the thighs), and lack of maxillary and vomerine teeth.

DESCRIPTION

Individuals from the Sydney area are rich chocolate brown above. The color is so deep that the animals appear almost black. The dorsal surfaces of the appendages, the side of the body, and the upper jaw have numerous tiny white dots. There may be a light tan stripe on the tip of the snout. The only feature that is at all distinctive in the coloration of the dorsal surface is a yellowish or orange area at the base of the arm. This is not so striking as in *Pseudophryne dendyi* and is usually not apparent unless the arm is stretched. In many individuals this yellow patch is indistinct or absent.

There is generally a pale horizontal line that connects the two post-femoral glandular areas. This line may expand into a small yellow or orange spot in the cloacal area. The skin over the post-femoral gland is a dull brick red.

The under parts, except for the central area of the thighs, are dark brown or black heavily mottled with white. The white areas may form small or large blotches. The central area of the thigh is dark, with only small white dots.

The back has numerous small warts, which occasionally join to form ridges. The ventral surface is nearly smooth. In some individuals the sides of the body and the posterior portion of the abdomen are granular.

Pseudophryne bibroni is a small stocky species. The largest individual that I have seen, which is from Killara, New South Wales, has a body length of 30.5 mm. Twelve specimens from Killara and Lindfield, now in the American Museum of Natural History, vary from 20.8 to 30.5 mm. in body length and have a tibia length/body length ratio of 0.30 ± 0.01 (0.27–0.33).

There is no tympanic membrane.

The fingers are not webbed. The palm of the hand, except for the tubercles, is pigmented. There is a large outer metacarpal tubercle, and a small inner one. The fingers are not pigmented, in contrast to those of *Pseudophryne australis*, which have all but the tips pigmented. The sequence of finger

length is $3 > 4 > 2 > 1$. The second and fourth fingers are nearly equal, but the first finger is much shorter than the second.

The foot is fleshy. The toes are not webbed. There are a medium-sized inner metatarsal tubercle, and a minute outer one. The sole of the foot is dark, except for the tubercles. The toes are pale, differing from those of *Pseudophryne australis*.

The tongue is narrow. There are neither vomerine nor maxillary teeth.

There are no illustrations for the open mouth, hand, and foot, as these structures are nearly the same as those of *Pseudophryne australis* (fig. 33).

GEOGRAPHIC VARIATION

Pseudophryne bibroni exhibits considerable geographic variation, but its small size has probably saved it from the splitters. One example is here given—a comparison of individuals from the New England area (Ben Lomond and Booroolong Creek, near Armidale) and Killara, both in New South Wales.

Individuals from New England are lighter below than those of Killara. The throat is usually mottled in the same way as the abdomen, whereas in most Killara specimens the throat is very dark. The yellow patch on the arm is inconspicuous. There is a rather prominent yellow spot on the post-femoral gland. In Killara specimens this is usually brick red or at most pale yellow. Although the two populations differ noticeably in their color patterns, the body proportions are similar, for the body length of 14 New England individuals varies from 22.3 to 26.8 mm., and the tibia length/body length ratio is 0.29 ± 0.01 (0.27–0.32).

Many other areas seem to have their distinctive populations, each differing in some slight, though constant, manner. An individual from Gladstone, Queensland, had a brick red patch on its head, similar to the bright red patch of *Pseudophryne australis*. I have never encountered this elsewhere. Occasionally *Pseudophryne bibroni* of other areas may have a head patch, but it is a dull tan or dull yellow.

HABITAT

The habitat of this species in the Sydney area is discussed in the section on *Pseudo-*

phryne australis. Briefly, *Pseudophryne bibroni* and *Pseudophryne australis* usually have distinct habitats, the former on shale and the latter on sandstone.

Pseudophryne bibroni is a terrestrial species that occurs in moist areas near streams and ponds (pl. 28, figs. 1, 2; pl. 29, fig. 1). It is found under logs and stones, or hidden under leaves and grass, or underground. I have never encountered it above ground, either by night or day.

Fletcher (1889) found *Pseudophryne bibroni* estivating in the soil on the bottom of a dry pond.

Harrison (1922) discusses the habitats of this species in the Sydney area. Eggs are laid "about the margins of the sluggish streams and stagnant ponds of the flat shale country."

VOICE

I could not distinguish its call from that of *Pseudophryne australis*, which is a nasal "ank ank."

Ross (1908a) describes it as "being somewhat like the noise made by gently striking a wax match on the rough end of a box."

BREEDING HABITS

Pseudophryne bibroni was first encountered at Killara on November 27. A single individual was found under leaves about 100 feet from the site where it was to breed much later. It was not seen again until April 15 when it was breeding (refer to the section on *Pseudophryne australis*).

Fletcher (1889) reports that clasping is in the inguinal position. He found ova during April, May, and June. The ova develop if kept moist, but they need not be in water.

Harrison (1922) writes that in *Pseudophryne bibroni* the "eggs are laid under logs, etc., close to water, in an irregular mass, but it does not dig a nest. On one occasion I found spawn exposed in a hole made by a cow's hoof in the muddy margin of a stream. I have found spawn commonly at Gordon during April and May. A pair of these frogs captured in embrace laid 130 eggs in twenty-four hours. . . . The egg measures 2 mm. in diameter, and the jelly 4 mm." He gives a description of the hatching of the larva.

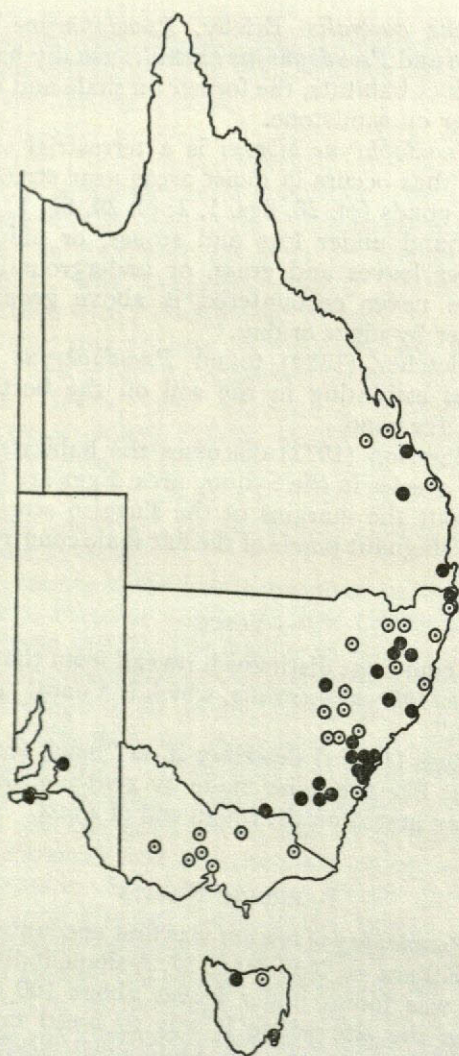


FIG. 35. *Pseudophryne bibroni*. Geographic distribution.

EMBRYONIC DEVELOPMENT

Embryos from four nests were collected at Killara, New South Wales, on April 15, 1953. The youngest were middle blastulae. The embryos were kept at a temperature of approximately 21° C. Their development is described only very briefly, as it resembles that of *Pseudophryne australis* very closely.

The diameter in the middle blastular stage is 2.1 mm., which makes the animals smaller than *Pseudophryne australis*. The unequal distribution of pigment in the animal hemisphere, which was so noticeable in *Pseudophryne australis*, occurs in this species as well,

but the relation to the cleavage planes was not established. These embryos have more pigment than *Pseudophryne australis*.

As the egg is smaller in *Pseudophryne bibroni* than in *Pseudophryne australis*, the early embryo is more like *Rana* in not being perched on the top of a large spherical yolk mass. There are no external gills, and, in the manner that the operculum is formed, this species resembles *Pseudophryne australis*. The hind-limb buds appear when the embryo is 9.5 mm. in length, a stage reached in 13 days. Hatching occurs at this time.

The tadpoles are more heavily pigmented than those of *Pseudophryne australis*, even the tail fins being involved. The teeth and jaws begin to form on the seventeenth day. The spiracle is on the left, and the anus opens to the right. Observations were not made on later stages.

GEOGRAPHIC DISTRIBUTION

Pseudophryne bibroni occurs along the periphery of the continent from Rockhampton, Queensland, to Adelaide, South Australia. It occurs also in Tasmania (fig. 35). The type locality is Australia and Tasmania.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Tweed River [Nos. 6492, 8490 (part)]
 Tamworth (No. 10772)
 Bearbong (No. 7405)
 Barrington Tops (No. 8973)
 Tubrabucca, Barrington Tops (Nos. 13304-13306)
 Myall Lakes (Nos. 7919, 11662)
 Bulahdelah (No. 8096)
 Blue Mountains (No. 4225)
 South Bowenfels (No. 13392)
 Hartley, Blue Mountains (No. 1363)
 Jenolan Caves district (No. 10469)
 Penrith (No. 1915)
 Lindfield (Nos. 4414-4446, 5217, 5218)
 French's Forest (No. 13422)
 Manly (Nos. 7372-7375)
 Mosman's Bay (Nos. 4107, 4108)
 Cook's River, Petersham (No. 384)
 Raymond Terrace (No. 9167)
 Moss Vale (Nos. 444, 445)
 Bundanoon [No. 8637 (part)]
 Illawarra [Nos. 6939-6942, 7378, 7379 (part)]
 Yass [No. 7397 (part)]
 Bungendore (No. 7329)

Tumut (No. 9648)
Talbingo (No. 12085)

The American Museum of Natural History has specimens from:

Ben Lomond (Nos. 65160-65166)
Booroolong Creek, 20 miles northwest of Armidale (Nos. 65155-65159)
Ebor (Nos. 20065-20069, 65167, 65168)
Killara (Nos. 65169-65174)
Lindfield (Nos. 13320-13325)
Parramatta (Nos. 23859-23862)
Burradoo (Nos. 65153, 65154)
Albury (Nos. 65151, 65152)

A.M.N.H. No. 23862 has two *Batrachomyia* parasites.

There are literature records for Clarence River, Port Macquarie, Walcha, Huskisson (H. W. Parker, 1940), Dunoon, Narrabri, Coolah, Guntawang near Mudgee, Capertee (Fletcher, 1890), Lucknow near Orange, Wellington Caves (Fletcher, 1892), Bald Knob near Glen Innes, Glen Innes, Inverell, and Bathurst (Fletcher, 1894b).

AUSTRALIAN CAPITAL TERRITORY

The American Museum of Natural History has specimens from:

Canberra (No. 65150)
Paddy's River (Nos. 65148, 65149)

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Eidsvold (Nos. 5322-5324, 5824, 5825, 5917, 5918, 6220-6227)
Brisbane (No. 5863)

The American Museum of Natural History has a specimen from:

Gladstone (No. 65175, with a large *Batrachomyia* larva)

There are literature records for Coomboolaroo and Kolonga Creek (Slevin, 1955) and Rockhampton (Boettger, 1892).

VICTORIA RECORDS

There are literature records for Sandhurst (H. W. Parker, 1940), Honeysuckle Track near Gelantipy (Brazenor, 1947), Benalla, Ballarat (Fletcher, 1891a), Grampians, Sandhurst, Macedon, and Gisborne (Lucas, 1892).

TASMANIA RECORDS

The Australian Museum has specimens from:

Ulverstone [No. 7601 (part)]
Port Arthur (No. 9829)
*Tasmania (No. 5236)

There are literature records for St. Patrick's River (Loveridge, 1935).

SOUTH AUSTRALIA RECORDS

The Australian Museum has specimens from:

Kangaroo Island, Birchmore Lagoon (No. 7136)
Kangaroo Island, Timber Creek (Nos. 7150-7156)

The American Museum of Natural History has a specimen from:

Adelaide (No. 23564)

There are literature records for *Torrens River (Loveridge, 1935).

LITERATURE

Duméril and Bibron (1841, 1854) had several specimens from Australia that they believed to be conspecific with *Bombinator australis* Gray. They referred to them, using a different generic name, as *Phryniscus australis*. According to H. W. Parker (1940) their species includes both *Pseudophryne bibroni* and *Pseudophryne semimarmorata*. Fitzinger's (1843) *Pseudophryne australis* was based on Duméril and Bibron's *Phryniscus australis*.

The first available name is *Pseudophryne bibronii* Günther (1858). Günther had several specimens from Australia and Van Diemen's Land. According to H. W. Parker (1940) only one of Günther's specimens is still in the British Museum (Natural History), and it is *Pseudophryne guentheri*. Parker suggests, nevertheless, that we use the name *Pseudophryne bibroni* for the species commonly known as *Pseudophryne bibroni*, as one or more of Günther's specimens could have been this species. I agree with Parker that we should pretend they were.

Other descriptions are given by Keferstein (1868a), Steindachner ("1869" [1867], with a dorsal and ventral view of an adult), Krefft (1870), Boulenger (1882), Ross (1908b), Lucas and Le Souëf (1909), English (1910), with a colored illustration), Andersson (1913a,

with illustrations of two adults; 1916, as *Pseudophryne australis* forma *bibronii*), Harrison (1922), Nieden (1923), Lord and Scott (1924), Waite (1929, with drawings of the palate, hand, and foot), Loveridge (1934, 1935), H. W. Parker (1940), Slevin (1955, with a photograph of an adult), and Moore (1957a).

Richard Deckert's (1915) description of "*Pseudophryne australis*" is actually of *Pseudophryne bibroni*.

Observations on habits are given by Fletcher (1889), Gadow (1901), Ross (1908a, 1908b), and Harrison (1922). Accounts on the habits in captivity can be found in Oertter (1955), Emmens (1955), Emmens and Gerber (1955), and Klingelhöffer (1956).

Various descriptions in the literature are as follows: of the skull, by William K. Parker (1881; probably a different species, according to H. W. Parker, 1940); of the depressor mandibulae muscle, by Griffiths (1954); of the pigmentation of the egg, by Harrison (1921); of the trematode parasites, by Johnston (1912); and of the *Batrachomyia* parasites, by Krefft (1864, as *Pseudophryne bibrenii*) and Skuse (1889).

References concerned primarily with data on distribution are Peters (1863), Krefft (1863, 1865, 1867), Günther (1867), Fletcher (1890, 1891a, 1892, 1894b), Boettger (1892, 1894), Lucas (1892, 1897), Kinghorn (1924), Waite (1927), Blanchard (1929), and Brazenor (1947).

There are minor references to *Pseudophryne bibroni* in Aflalo (1896), Fletcher (1898), Scott (1942), and Barrett (1943).

Pseudophryne dendyi Lucas

THE SOUTHERN TOADLET

Plate 40, figures 14, 15; text figure 36

DIAGNOSIS

This is a small species (body length usually less than 30 mm.), which is black on the dorsal surface and marbled black and white below. There are prominent yellow patches on the upper arms and in the cloacal region. There are neither vomerine nor maxillary teeth.

Pseudophryne dendyi can be confused only with *Pseudophryne bibroni*. In *Pseudophryne dendyi* the yellow patch on the arm is con-

spicuous, whereas in *Pseudophryne bibroni* it is inconspicuous. *Pseudophryne dendyi* always has a conspicuous yellow spot restricted to the cloacal region and proximal portion of the thighs. The post-femoral glands are not included. *Pseudophryne bibroni* may have some yellow on the posterior surface of the thighs; if so, the yellow is restricted to the post-femoral glands.

DESCRIPTION

The upper parts are very dark gray or black. The appendages, sides, and region below the eye are speckled with minute white dots. There is usually a light-colored median stripe on the tip of the snout. The upper arm has a prominent bright yellow patch; in some individuals it covers nearly the whole of the upper arm. There are conspicuous yellow patches on the cloacal region, which are subject to considerable individual variation. At one extreme the individuals have three small spots, one just above the cloacal opening and one nearby on the proximal portion of each thigh. In those individuals with the most extensive yellow areas there is a single, broad, horizontal band that includes the area above the cloacal opening and widens on the proximal portion of the thighs. The form of the patch, then, is roughly that of a dumbbell. The postfemoral glands are brown, in contrast to the rest of the thigh.

The under side is black, with conspicuous bluish white blotches.

The ventral portion of the thighs is granular, as is the case in other members of the genus. The rest of the skin is fairly smooth, except for some individuals that have small warts on the back.

This is another of the stubby species of *Pseudophryne*. The six individuals in the American Museum of Natural History vary in body length from 25.5 to 28.2 mm. Their mean tibia length/body length ratio is 0.30 ± 0.01 (0.28–0.31). The largest individual that I have seen is 29.5 mm. in body length (Australian Museum No. 2500, Pambula, New South Wales).

There is no tympanic membrane.

There are no webs between the fingers. The sequence of finger lengths is $3 > 4 > 2 > 1$, with the fourth finger very slightly longer than the

second and the second much longer than the first. The structure of the hand is very similar to that of *Pseudophryne bibroni*. The hand is heavily pigmented, except for the tubercles. There are two large metacarpal tubercles, which are very conspicuous, as they are nearly white against the almost black background color.

The foot is thick and fleshy. There are no webs between the toes. The foot is also heavily pigmented, except for the tubercles, which are conspicuous because they are nearly white. There are a large inner metatarsal tubercle, and a medium-sized outer one.

The tongue is narrow. There are neither vomerine nor maxillary teeth.

HABITAT

I encountered *Pseudophryne dendyi* at several localities in southeastern New South Wales and eastern Victoria. All the individuals were concealed, under either rocks or logs. They were found along dry stream beds (pl. 32, fig. 2), as well as along streams with running water. The sites varied in altitude from near sea level to almost 4000 feet.

VOICE

The call is a nasal "erk" like that of *Pseudophryne australis*.

BREEDING HABITS

Breeding adults were encountered once, on February 23, 1953, near Jindabyne, New South Wales. A nest containing about 85 embryos was in the form of a slight depression. It was under a stone and several inches from a small stream.

EMBRYONIC DEVELOPMENT

All my observations were made on the embryos mentioned above. Some of them were preserved when collected, and others were brought back to the laboratory for study.

The youngest embryos were in the four-cell stage. The diameter is 2.2 mm. The animal hemisphere is more heavily pigmented than in either *Pseudophryne australis* or *Pseudophryne bibroni* and there is the same unequal distribution of the pigment. Thus in the four-cell stage the animal hemisphere sections of

two of the cells are medium brown and of the other two pale tan.

The differences between this species and *Pseudophryne bibroni* or *Pseudophryne australis* in development are minor and need not be described in detail. It might be emphasized, however, that *Pseudophryne dendyi* does not possess external gills. The operculum forms as it does in other members of the genus. Hatching begins when the embryos are 11 mm. long, though some remain in the jelly much longer. The hind-limb buds form early. The spiracle opens to the left, and the anus to the right.

In the tadpole there are one continuous row and one interrupted row of teeth in front of the mouth and three continuous rows behind. The dorsal surface of the body and the lateral abdominal portions of the ventral surface are heavily pigmented. The median area of the abdomen and the anterior half of the ventral surface are nearly completely transparent. The myotome portion and the fins of the tail are pigmented.

GEOGRAPHIC DISTRIBUTION

Pseudophryne dendyi occurs in southeastern New South Wales and eastern Victoria (fig. 36) from near sea level to at least 3930 feet. The type locality is Wellington River, North Gippsland, Victoria, which is on Mt. Wellington.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Mt. Kosciusko (Nos. 572, 575)
Pambula (Nos. 2500, 2501)

The American Museum of Natural History has specimens from:

Bodalla (No. 65176)
Saw Pit Creek, 6 miles east of Hotel Kosciusko (No. 65178)
6 miles west of Jindabyne (No. 65177)

VICTORIA RECORDS

The American Museum of Natural History has specimens from:

15 miles north of Orbost (Nos. 65179, 65180)
Bonang (No. 65181)

Another record is the type locality, Wellington River, North Gippsland.

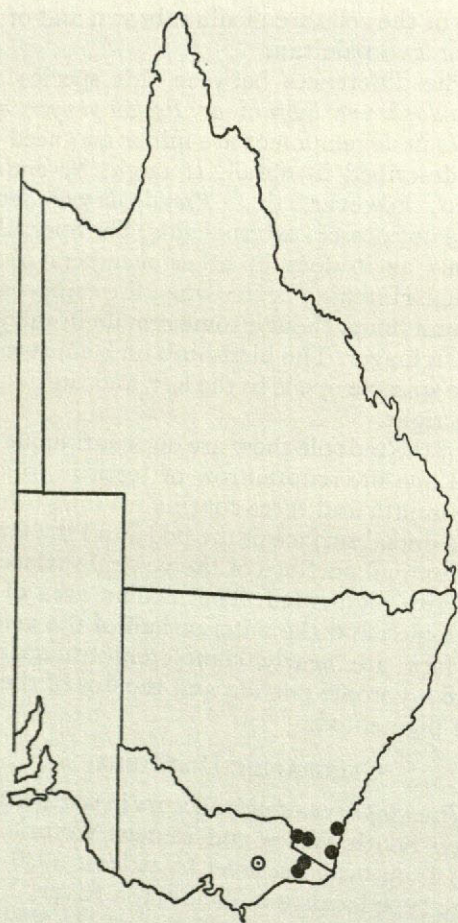


FIG. 36. *Pseudophryne dendyi*. Geographic distribution.

COMMENTS

Pseudophryne dendyi is a species of uncertain status. Lucas (1892) described it from a single specimen. According to Harrison (1927) the type is not in the National Museum in Melbourne and is presumed to be lost.

Fry (1912) implies that he had seen specimens for he writes, "Of the species described since the 'Catalogue' the three recently characterized by Mr. J. Lamb and *Philoria frosti*, Spencer, *Hyla gilleni*, Spencer, *H. dayi*, Günther and *H. maculata*, Spencer, are the only ones that I have not examined." He then expresses the opinion that *Pseudophryne dendyi* is "Probably *P. bibroni*." Nieden (1923) recognizes it.

Loveridge (1935) had specimens from the

Mt. Kosciusko area and the Blue Mountains of New South Wales that he referred to as *Pseudophryne dendyi*. H. W. Parker (1940) also recognized this species, and he listed two specimens, one from the Blue Mountains and the other from Barrington Tops.

The specimen that Parker examined from Barrington Tops is in the Australian Museum (No. 8973). To me it seems essentially the same as *Pseudophryne bibroni* of the Armidale region. These have the yellow patch on the arm better developed than in individuals from the Sydney area. Furthermore, there is considerably more yellow on the hind end of the body. This yellow, however, is mainly on the post-femoral glands. The same is true for some individuals from the Blue Mountains.

Believing that Parker's specimen of *Pseudophryne dendyi* was conspecific with *Pseudophryne dendyi* of Lucas, I first thought that both were *Pseudophryne bibroni*. My experience on a short collecting trip to southeastern New South Wales and eastern Victoria, however, makes this judgment doubtful. Here I found *Pseudophryne* with vivid yellow spots. These individuals agree with the original description of *Pseudophryne dendyi*, except that my specimens have post-femoral glands, which were not noticed by Lucas. Six individuals were collected, and these differ from *Pseudophryne bibroni* as described in the diagnosis. In the specimens I am calling *Pseudophryne dendyi*, the most prominent features are their more vivid coloration and the fact that the yellow patches are on the proximal portion of the thigh, whereas in *Pseudophryne bibroni*, the yellow, if present on the thigh, is over the post-femoral gland.

I would be sure of the validity of *Pseudophryne dendyi* had I collected *Pseudophryne bibroni* in the same locality. I did not. This point is not of great importance because of the very short duration of the collecting trip. I should add, however, that the Australian Museum does not have any *Pseudophryne bibroni* from the areas where my *Pseudophryne dendyi* were collected. As far as my limited experience goes, the two are allopatric but are probably different species.

LITERATURE

The type of *Pseudophryne dendyi* was a male (presumably juvenile) collected by Dr.

Dendy near the Wellington River, North Gippsland, and described by Lucas (1892). According to Harrison (1927) the type has been lost.

Other descriptions are given by Lucas and Le Souëf (1909), Nieden (1923), Loveridge (1935), and H. W. Parker (1940). (Loveridge's specimens from the Blue Mountains and Parker's specimens from the Blue Mountains and Barrington Tops are probably *Pseudophryne bibroni*.)

The species is mentioned by Lucas (1897), Fry (1912), and Andersson (1913a).

Pseudophryne coriacea Keferstein

KEFERSTEIN'S TOADLET

Plate 40, figures 10, 11; text figure 37

DIAGNOSIS

This small frog is distinguishable from all others in eastern New South Wales by its color pattern which is the reverse of that usual in frogs: the dorsal surface is pale (reddish in life), and the sides and ventral surface are much darker.

Pseudophryne coriacea could be confused only with the *affinis* color type of *Grinia signifera*, but the pale cloacal patch, white pectoral spots, and maxillary teeth of the latter all are absent in *Pseudophryne coriacea*. In addition, *Pseudophryne coriacea* has yellow post-femoral glands and a yellow spot on the anterior side of the thigh, and these are absent in *Crinia signifera*.

DESCRIPTION

I never saw *Pseudophryne coriacea* alive; this is regretted as it must be a very spectacular frog. This description is based on specimens in the American Museum of Natural History.

The dorsal surface of preserved specimens is brown or tan, with or without a few inconspicuous darker spots. The sides of the body are dark brown. Usually there is a sharp junction between the dark coloration of the side and the lighter coloration of the dorsal surface, reminding one of the *affinis* color type of *Crinia signifera*. There may be a pale patch, as in *Pseudophryne bibroni*, on the proximal end of the arm.

The ventral surface has the bold mottlings of other species of *Pseudophryne*. The back-

ground is dark brown, and the light areas are pale yellow. The ventral surfaces of the arms and legs are cross-banded with dark brown and yellow. There is a yellow patch on the proximal end of the anterior side of the thigh, and there is another on the distal end of the posterior side.

The dorsal and ventral surfaces are nearly smooth, except for the ventral portion of the thigh, which is granular. There is usually a skin fold that extends from the eye, along the side, to the groin.

Pseudophryne coriacea is a stocky species. The largest individual that I have seen is a female from New South Wales with a body length of 33.4 mm. (Australian Museum No. 5237). H. W. Parker (1940) gives the maximum sizes for males as 28 mm. and females 34 mm. The four specimens in the American Museum of Natural History vary in body length from 23.3 to 27.8 mm. The mean tibia length/body length ratio is 0.33 ± 0.01 (0.31–0.35).

There is no tympanic membrane.

The fingers are poorly developed. The length sequence is $3 > 4 > 2 > 1$. The second and fourth are nearly equal, and the first is much shorter than the second. There are no webs. The hand is pigmented, except for the tubercles. There is a large outer metacarpal tubercle.

The toes are poorly developed, the first being minute. There are no webs. The ventral side of the foot is pigmented, except for the tubercles. There are small, flat, inner and outer metatarsal tubercles.

The tongue is narrow. There are neither vomerine nor maxillary teeth.

Stephen Copland, who collected the four specimens now in the American Museum of Natural History, made the following notes on the color of living individuals from Hickey's Creek: "Dorsally rusty orange red, laterally black, ventrally black with white to ivory marbling, scattered light spots on sides and upper lip; large white or ivory spots in axillae, across forearm and almost banding hind limbs."

HABITS

Nothing has been reported concerning the habits, voice, or life history of *Pseudophryne coriacea*.

GEOGRAPHIC DISTRIBUTION

Pseudophryne coriacea occurs along the east Australian coast from Gayndah in southern Queensland to Morisett in central New South Wales (fig. 37). The type locality is the Clarence River of New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Gurravembi, Nambucca River (Nos. 6307, 6308)
- Beechwood, Hastings River (No. 6933)
- Port Macquarie (Nos. 6274-6276, 10287)
- Wallis Lake, Tuncurry (No. 7624)
- Bulahdelah (No. 8089)
- Williams River (No. 9229)
- Morisett (Nos. 3458, 3459)
- *Far north coast (No. 13254)
- *New South Wales (No. 5237)
- *No locality (Nos. 6877, 7345)

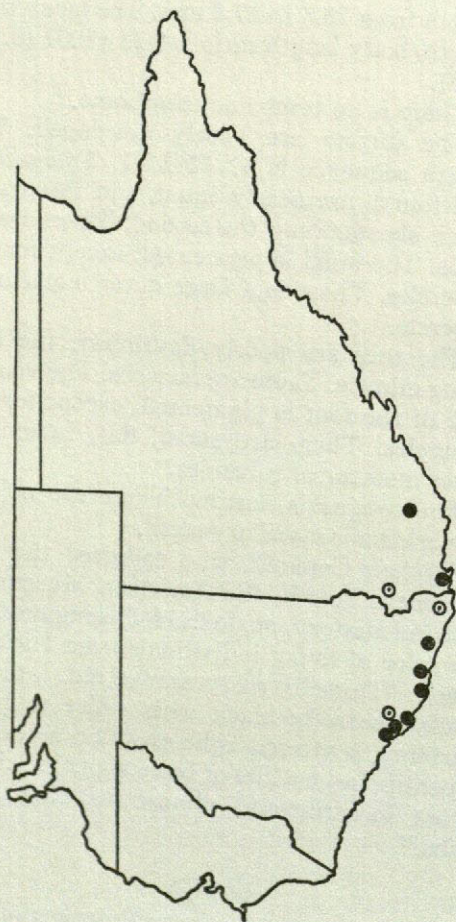


FIG. 37. *Pseudophryne coriacea*. Geographic distribution.

The American Museum of Natural History has specimens from:

- Horton's Creek, 5 miles from Nymboida (Nos. 65197-65199)
- Hickey's Creek, 10 miles southeast of Bellbrook (No. 65196)

There are literature records for the Clarence River (Keferstein, 1868a), Dunoon on the Richmond River (Fletcher, 1890), Salisbury (Loveridge, 1935), Lake Macquarie (H. W. Parker, 1940), and Ulong (Slevin, 1955).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

- Gayndah (Nos. 7425, 7431)
- Pimparna (No. 7412)

There is a literature record for Waroo, Inglewood (Fletcher, 1892). This is surprisingly far inland for *Pseudophryne coriacea*.

LITERATURE

Pseudophryne coriacea was described by Keferstein (1868a), who provided a good illustration of the adult. The type locality is the Clarence River of New South Wales. An essentially identical description, but without an illustration, is given by Keferstein (1868b). Apparently Krefft (1865) was referring to this species when he wrote: "*Pseudophryne* (new species). This is a very distinct species, and the largest of this genus yet discovered; it is of a uniform brick red color on the back, beneath black and white marbled. Hunter River district."

Other descriptions are to be found in Boulenger (1882), Lucas and Le Souëf (1909, as a color variety of *Pseudophryne bibroni*), Nieden (1923), Loveridge (1935), H. W. Parker (1940), and Slevin (1955).

References concerned primarily with geographic distribution are by Fletcher (1890, 1892, 1894b).

Minor mention of the species is made by Afalo (1896) and Andersson (1913a).

Pseudophryne corroboree Moore

THE CORROBOREE TOADLET

Plate 40, figures 4, 5; text figure 38

DIAGNOSIS

Pseudophryne corroborae is a small and toothless species that can be distinguished from all other Australian frogs by its striking pattern of longitudinal black and yellow stripes on the back.

DESCRIPTION

There is surprisingly little variation in the individuals of this species that I have seen. The back is yellow, with black stripes. There are four black stripes on the back at the level of the arms. A little posteriorly the two inner stripes split to form a total of six. There is a V-shaped black bar that crosses the head at the level of the eyes. A black stripe extends along the canthus rostralis to the eye.

The sides, abdomen, and dorsal and ventral surfaces of the appendages are boldly marked with black and bright yellow and pale blue.

Colefax (1956) gives measurements for 11 adult individuals. The body lengths vary from 25 to 31 mm. The upper limit is for a female, and this is the largest individual reported. The mean tibia length/body length ratio is 0.33 ± 0.01 (0.27–0.37). The type and four specimens from Smiggins Hole, Mt. Kosciusko, which I have measured, have body lengths varying from 24.0 to 26.4 mm. The mean tibia length/body length ratio is 0.32 ± 0.01 (0.29–0.34).

There is no tympanic membrane.

The fingers are poorly developed and without webs. The tubercles on the hand and fingers are but slight elevations. The hand itself is black, and the tubercles are whitish. The sequence of finger lengths is $3 > 4 > 2 > 1$.

The toes are likewise poorly developed and without webs. The foot is fleshy. The sole is black, usually with a large, whitish, central spot. The tubercles are whitish and feebly developed. There is an inner, but no outer, metatarsal tubercle.

The tongue is small and narrow. There are neither maxillary nor vomerine teeth.

HABITAT AND HABITS

This is a mountain species. All the information concerning the habits and habitats is given by Colefax (1956). *Pseudophryne corroborae* has been collected from "under logs and other debris" in boggy areas and in bur-

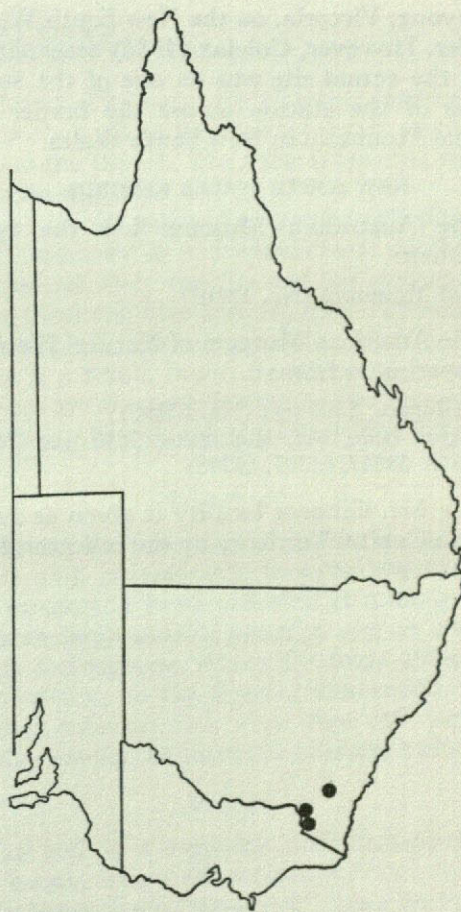


FIG. 38. *Pseudophryne corroborae*. Geographic distribution.

rows, sometimes as much as 10 inches deep, in sphagnum.

Breeding is reported to occur "during the second half of December and the early part of January" in the Mt. Kosciusko area. Eggs are deposited in burrows in the sphagnum, each female laying about 12.

VOICE

The voice is much like that of the other members of the genus. It may be described as a nasal "wrack," the duration of the note being about one second.

GEOGRAPHIC DISTRIBUTION

Pseudophryne corroborae is known only from the mountains of southern New South Wales (fig. 38). The type locality was originally stated as Towong Hill Station, which is near

Corryong, Victoria, on the New South Wales border. However, Colefax (1956) ascertained that the actual site was on one of the snow leases of the station across the border on Round Mountain in New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has the type specimen:

Round Mountain (No. 13103)

The American Museum of Natural History has specimens from:

Mt. Gingera, 5500 feet (No. 65195)

Smiggins Hole, Mt. Kosciusko, 5650 feet (Nos. 63862, 63863, 64297, 64298)

The Mt. Gingera locality is given as Australian Capital Territory by the collector, but

Colefax (1956) says the locality is actually in New South Wales.

LITERATURE

Pseudophryne corroboree was described by Moore (1953). The type locality is Round Mountain, New South Wales, and not Towong Hill Station, Corryong, Victoria, as stated (Colefax, 1956). The holotype is in the Australian Museum.

Colefax (1956) has assembled all available information on the structure, distribution, embryology, and habits of the species. Discussions of its habits in captivity are given by Emmens (1955, with a photograph of the adult), Emmens and Gerber (1955, with a photograph of the adult), and Klingelhöffer (1956, with a photograph of an adult).

THE FAMILY HYLIDAE

Hyla bicolor (Gray)

THE DWARF TREE FROG

Plate 41, figure 1; text figures 39, 40

DIAGNOSIS

A small green *Hyla* with a smooth skin on the back and well-developed discs on the fingers and toes. No vomerine teeth. Orange (not brick red) markings on the hind legs. A white or yellowish (but not golden) line extends from *beneath* the eye to the shoulder or in some specimens somewhat more posteriorly.

DESCRIPTION

The upper parts are leaf green. A golden brown line extends from the nostril to the eye. There is a white or yellowish line that begins below the eye and extends along the upper jaw and the ventral side of the tympanic membrane to the arm. In some individuals it continues along the side nearly to the groin. The anterior and posterior surfaces of the thigh are orange or yellowish orange.

The ventral surface is entirely white except for the edge of the lower jaw, which is green, and except for the throat of the male, which is dusky, with a faint orange wash.

The skin on the dorsal surface and throat is smooth. There is a prominent fold of skin across the chest, and, posterior to this, the skin is granular.

This is a slender and diminutive species. The largest individual that I have seen is 32.6 mm. in body length. It is from Gurravembi, New South Wales (Australian Museum No. 6318). The proportions of 10 specimens from east central New South Wales (Warrah, Plumpton, and Richmond), which vary in body length from 20.6 to 28.5 mm., are: tibia length/body length, 0.51 ± 0.01 (0.48–0.55); head length/body length, 0.31 ± 0.01 (0.29–0.34); head width/head length, 0.97 ± 0.01 (0.94–1.03).

The tympanic membrane is clearly visible. The vocal sac of the breeding male is beneath the chin and so large that even when deflated it hangs loosely.

There is a trace of a web between the fingers, and the discs are moderately well

developed. The sequence of finger lengths is $3 > 4 > 2 > 1$. Breeding males have nuptial pads on the thumb. The palm is covered with tubercles (fig. 39).

The web between the toes is well developed, especially in individuals from northern Queensland. Only the disc and half a phalanx of the third and fifth toes are free. The fourth toe has the disc and one phalanx free (fig. 39). There is a small, inner, metatarsal tubercle.

There are no vomerine teeth. The tongue is moderately broad and slightly nicked behind (fig. 39).

HABITAT

The typical habitats of *Hyla bicolor* are ponds with considerable floating vegetation and swamps. I have collected it among the reeds in large coastal swamps and in small ponds and lagoons, where the frogs are generally sitting on the floating vegetation. On another occasion they were observed during the day among the leaves of pineapple plants.

VOICE

The call is a squeaky and high-pitched "wr-e-e-ek, wr-e-e-ek, wr-e-e-ek," continued many times. Each "wr-e-e-ek" has a duration of about one second.

GEOGRAPHIC DISTRIBUTION

Hyla bicolor is found on the periphery of Australia from the northern part of Western Australia to central New South Wales (fig. 40). It also occurs in New Guinea and the Aru Islands.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Richmond River (No. 5083)
- Nambucca River (No. 4635)
- Warrell Creek, Nambucca River (Nos. 4252, 4636)
- Gurravembi, near Macksville, Nambucca River (Nos. 6185, 6318, 6320)
- Bulahdelah (No. 8095)
- Capertee (No. 10773; identification not positive; juvenile)
- Tuggerah (No. 10534)
- Ocean Beach, Woy Woy (Nos. 8856, 8857)

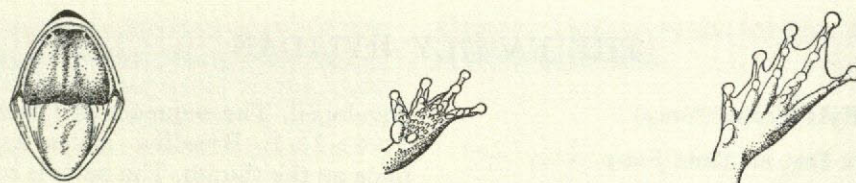


FIG. 39. *Hyla bicolor*. Open mouth, hand, and foot. A.M.N.H.
No. 62511. Thomas' Lagoon, Armidale, New South Wales.

Upper Colo, via [near] Richmond (Nos. 7975, 7976)

Clyde, near Sydney (Nos. 4671, 4672)

Seven Hills, Parramatta (No. 4479)

The American Museum of Natural History
has specimens from:

Thomas Lagoon, Armidale (Nos. 62510-62513)

Warrah, near Woy Woy (Nos. 62514-62520)

Richmond (Nos. 62508, 62509)

Plumpton, near Penrith (Nos. 62505-62507)
Sydney (Nos. 6965, 6967)

The British Museum has a specimen from:

Blue Mountains (No. 64.7.6.15)

Additional localities for which I have only
literature records are: Ulong (Slevin, 1955),
Kilbride near Campbelltown, Razorback
Mountain near Picton, 10 miles north of

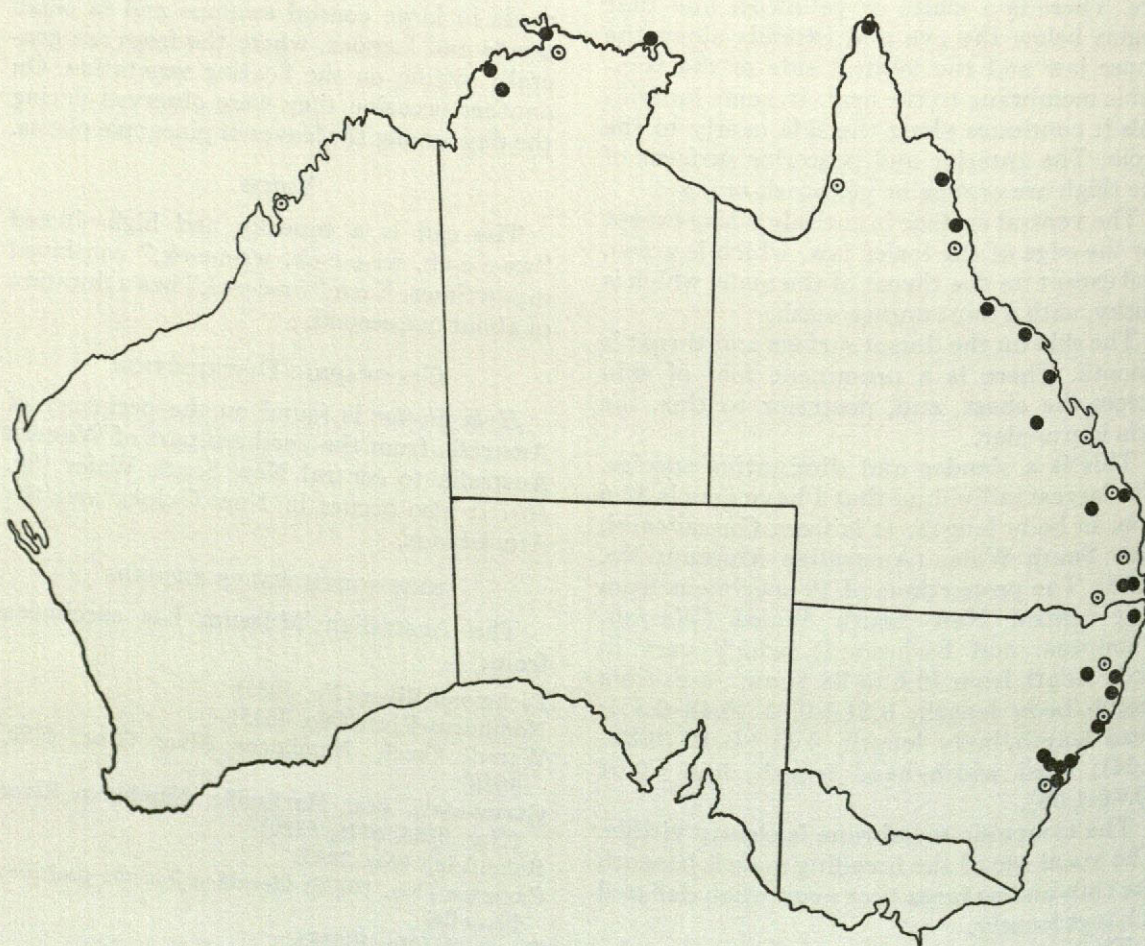


FIG. 40. *Hyla bicolor*. Geographic distribution.

Raymond Terrace, Failford, and near Tun-
curry (Copland, 1957).

6 miles west in Arnhem Land (Mitchell,
1955).

QUEENSLAND RECORDS

The Australian Museum has specimens
from:

Somerset, Cape York (No. 4535)
*Cape York (No. 9591)
Cooktown (No. 1520)
*Herbert River (No. 6655)
Townsville (No. 6944)
Barolin Station, Bundaberg (No. 10574)
Eidsvold (Nos. 5921, 6114)
Mt. Tambourine (No. 8942)
Brisbane (Nos. 5514, 5866)

The American Museum of Natural History
has specimens from:

Lockerbie, 10 miles west-southwest of Somerset
(No. 54201)
Annan River, 15 miles south of Cooktown (Nos.
54342-54345)
Cairns (Nos. 62494-62503, plus four not num-
bered)
West Cairns (No. 54182)
Mackay (No. 62504)

The British Museum has specimens from:

*Cape York (No. 67.3.13.32)
Port Denison, Bowen (Nos. 64.7.8.3, 64.7.8.4)
Peak Down (Nos. 76.3.4.44, 76.3.4.45)
Brisbane (No. 64.7.6.16)

Additional localities for which I have only
literature records are: Alice River, interior of
Cape York (Andersson, 1916), Bellenden Ker
Range (Loveridge, 1935), Kolonga Creek, 25
miles north of Gin Gin (Slevin, 1955), and
Emu Park, Kilcoy, and 15 miles west of
Karara (Copland, 1957).

NORTHERN TERRITORY RECORDS

The Australian Museum has specimens
from:

Darwin area (No. 12896)
Echo [sometimes spelled Elcho] Island off Arnhem
Land (No. 12425)

The British Museum has specimens from:

Port Essington (No. 42.1.24.22, reregistered as
1947.2.22.59; type)
Port Darwin (Nos. 91.6.25.23, 91.6.25.24)
Adelaide River (Nos. 92.1.14.12-92.1.14.16)

Additional localities for which I have only
literature records are: Oenpelli and localities

WESTERN AUSTRALIA RECORDS

Copland (1957) lists 15 specimens from
Watjulum Mission in northwest Western
Australia.

GEOGRAPHIC VARIATION

Copland (1957) recognized two subspecies,
Hyla bicolor bicolor (Gray) and *Hyla bicolor*
glauerti, which he described as new. The typi-
cal form, with the type locality of Port
Essington, Northern Territory, occurs across
the northern part of Australia and south to
central Queensland. *Hyla bicolor glauerti*,
with Colo (near Sydney), New South Wales,
as the type locality, occurs in the coastal
areas of southern Queensland and New South
Wales. He states: "*H. b. bicolor* is chiefly dis-
tinguished because of its extreme slenderness.
The width of the head is contained on an
average 3.52 times in the total length of head
and body as compared with 3.07 times for *b.*
glauerti. The slender habitus is still further
emphasized by the fact that only about 7%
have the body wider than the head while this
occurs in about 80% of *glauerti*."

These differences are not apparent in the
specimens I collected. A comparison was
made between the body proportions of the 10
individuals from New South Wales men-
tioned above in the description (these would
be in the range of Copland's *H. b. glauerti*)
and 10 Queensland individuals (nine from
Cairns and one from Mackay). The Queens-
land individuals are within the range of
Copland's *H. b. bicolor*. My specimens seem
to show an insignificant difference in degree of
slenderness, as the data in table 3 indicate.
There is no difference in the head width/head
length ratio.

On the basis of the material now available
to me in the American Museum of Natural
History, I do not believe that there is any
need to recognize subspecies in *Hyla bicolor*.
In fact I have always thought of this species
as exhibiting less geographic variation than
many other Australian frogs. Two points
should, however, be borne in mind. First, I
have not seen the Western Australia speci-
mens about which Copland writes: "Differ-

TABLE 3
A COMPARISON OF BODY PROPORTIONS OF TEN NEW SOUTH WALES AND
TEN QUEENSLAND *Hyla bicolor*

	New South Wales	Queensland
Body length		
Range	20.6 -28.5 mm.	20.2 -24.8 mm.
Body length/head width		
Mean	3.36	3.48
Standard error of mean	0.3	0.3
Range	3.12- 3.48	3.31- 3.61
Head width/head length		
Mean	0.97	0.98
Standard error of mean	.01	.01
Range	0.94- 1.03	0.91- 1.04

ences between the typical race and that living in the south-east were not realized until the Watjulum series of *bicolor* from the extreme north-west corner of Australia was compared with N.S.W. individuals." Second, I have an exceedingly poor eye for detecting subspecies in frogs.

LITERATURE

The species now known as *Hyla bicolor* was first described as *Eucnemis bicolor* Gray (1842). The type locality is Port Essington. The type specimen is in the British Museum (Natural History). Thereafter the species was transferred by various authors to the genus *Hyperolius*, then to *Hylella* (which differed from *Hyla* in lacking vomerine teeth), and finally to *Hyla*. *Hylomantis fallax* Peters (1881, with figures of the adult, open mouth, foot, and shoulder girdle) from Port Bowen, Mackay, and Rockhampton has been regarded by Boulenger (1882) and later workers as a synonym.

General descriptions are given under the name *Hyperolius bicolor* by Günther (1858) and Krefft (1870); under the name *Hylella bicolor* by Boulenger (1882), Boettger (1894), and Lucas and Le Souëf (1909); under the name *Hyla bicolor* by van Kampen (1906 and 1923, New Guinea and Aru Island specimens and with the description of a tadpole that is probably not this species), Roux (1910), Nieden (1923, with an illustration of the tadpole described by van Kampen reproduced), Loveridge (1948), Slevin (1955, with a photograph of the adult), and Copland (1957, in

which he recognizes two subspecies, *Hyla bicolor bicolor* and *Hyla bicolor glauerti*).

References that consist largely of data on distribution are: Fletcher (1894b) and Anderson (1916) as *Hylella bicolor*; and van Kampen (1909, 1914), Loveridge (1935), and Mitchell (1955) as *Hyla bicolor*. Observations on habits are given by Krefft (1865, as *Hyperolius bicolor*). The skull and hyobranchials are described by William K. Parker [1881, as *Rappia (Hyperolius) bicolor*].

The species is mentioned by Günther (1867, as *Eucnemis bicolor*), Krefft (1867, as *Hyperolius bicolor*), Kesterstein (1868a, as *Hyperolius bicolor*), Fletcher (1889, 1890, 1892, as *Hylella bicolor*), Roux (1920), and Mertens (1958a).

The name *Hyla bicolor* can be justified on the basis of long usage, although it first referred to the South American species now known as *Phyllomedusa bicolor* (Boddaert). The South American form was described as *Rana bicolor* in 1772, *Hyla bicolor* in 1803, and *Phyllomedusa bicolor* in 1830. The Australian species was described as *Eucnemis bicolor* in 1842, *Hylomantis fallax* in 1880, *Hylella bicolor* in 1882, and *Hyla bicolor* in 1906. The use of *Hyla bicolor* for the Australian species should not lead to any confusion; it comes within the "fifty year rule," and is permitted by the International Commission on Zoological Nomenclature (see Mayr, Linsley, and Usinger, 1953, pp. 225-226). I hope that no one will feel it necessary to abandon the name *Hyla bicolor*, which has been used for so long for this species.

Hyla phyllochroa Günther

THE LEAF GREEN TREE FROG

Plate 41, figure 2; text figures 41, 42

DIAGNOSIS

A combination of features separates this species from all others in the area under consideration: well-developed discs on fingers and toes; dorsal surface uniform green (but see below); a golden line extending from the nose across the top of the eyelid and tympanic membrane to the shoulder region; and brick red (not tan or orange) flash markings on the groin and anterior and posterior surfaces of the thigh.

DESCRIPTION

The color of the back and dorsal surface of the appendages is usually leaf green in individuals caught at night, but during the day the color may be olive-brown or brown. There is a golden line extending from the nose to the eye and from the eye across the top of the tympanic membrane and then along the side of the body to the shoulder region. This line gradually merges with a zone of small yellow spots, which may extend halfway down the side to the groin. There is a narrow dark brown line contiguous with, and ventral to, the golden line. The axilla, groin, and anterior and posterior surfaces of the thigh are brick red. The colored areas of the axilla and groin may be so elongated that a continuous brick red band is formed along the side of the body.

The chest and abdomen are white. The ventral surface of the arm and leg is generally yellowish. The edge of the lower jaw is greenish or brown, and the entire throat may be mottled in both males and females. The ventral surface is granular, especially the area posterior to the pectoral girdle.

This description applies to individuals from the vicinity of Sydney, which is the type locality. Individuals from Armidale, New South Wales, and Binna Burra, Queensland, may lack the brick red band on the side, and the mottling of the ventral side may involve not only the throat but also the anterior half of the abdomen.

This is a small frog. The largest individual I have seen, which was collected on the Grosse River near Blackheath, New South Wales, is 41 mm. in body length. The body proportion ratios of 10 adults from Killara, New South Wales, which vary in length from 27.7 to 31.9 mm., are: tibia length/body length, 0.52 ± 0.00 (0.50–0.55); head length/body length, 0.34 ± 0.00 (0.33–0.35); head width/head length, 1.06 ± 0.01 (1.03–1.11).

The eyes protrude noticeably when the animal is viewed from above. The iris is golden.

The tympanic membrane is distinct.

The fingers have a vestigial web and large adhesive discs (fig. 41). The length sequence is $3 > 4 > 2 > 1$.

The toes have a well-developed web (fig. 41). The fifth toe is webbed to the disc. The fourth toe has the disc and one phalanx free. The fourth toe is not so long as it is in most frogs. There is a small inner metatarsal tubercle.

The vomerine teeth are poorly developed (fig. 41). Of 31 large individuals in the American Museum, vomerine teeth are present in 30, although indistinct in eight of these. In a single frog they are present on one side only. The posterior margin of the vomerine teeth is behind the level of the posterior edge of the choanae.

HABITAT

Hyla phyllochroa is less aquatic than *Hyla*

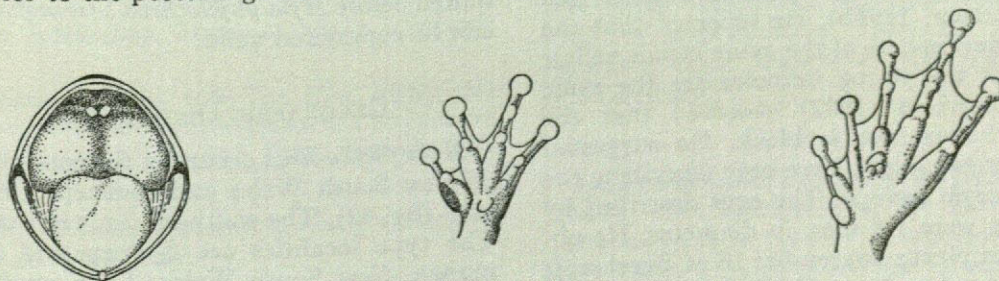


FIG. 41. *Hyla phyllochroa*. Open mouth, hand, and foot. A.M.N.H. No. 62533. Killara, New South Wales.

bicolor. At night I have usually found it sitting on the leaves of plants growing beside streams (pl. 28, fig. 1; pl. 32, fig. 2) or in very moist situations. Its color matches closely that of the green leaves. Occasionally individuals have been observed at night sitting on dark stones or sticks, and these individuals were brown. It was interesting to note how closely the background color was imitated even though it was night.

This is not a timid species, and the individuals can be easily picked off the plants where they are found.

At Killara, New South Wales, where I did field work for nearly one year, the males were first heard calling on November 2, 1952. They were last heard on April 28, 1953, although by this time they were calling infrequently.

VOICE

The call is a loud, whirring, "wrk-wrk-wrk." On another occasion I described it as "cruk-cruk-cruk-gruu-gruu." The frog calls during the day, though infrequently. Harrison (1922) described the call as "kuk-kuk-kuk."

BREEDING HABITS

Spawning was never observed, but I found eggs, probably of this species, on November 29 and December 2 near Sydney. The eggs were in loose masses in a small recess formed by stones at the edge of a stream. The jelly layers around each egg were quite thick, and the eggs were therefore well separated. The color of the animal hemisphere was a rich dark brown.

A clasping pair consisting of two males was observed on one occasion. The embrace was pectoral.

Fletcher (1889) observed clasping pairs in December, January, and February. He believed that breeding begins in October (see also Fletcher, 1894b). He reported that the animal hemisphere of the ovum is pale yellow and that the young tadpoles are the same color. Harrison (1922) observed that the animal hemisphere is black. He suggested that Fletcher might have been describing the eggs of *Hyla ewingii*. The eggs described by Harrison were 1.2 mm. in diameter. He observed amplexus September 18 at Beechcroft and September 21 at Gordon, both in New South Wales.

COMMENTS

I collected two interesting individuals (A.M.N.H. Nos. 62524, 62525) at Ebor, New South Wales, that are fairly typical of *Hyla phyllochroa* (including the presence of vomerine teeth) except that one has a prominent pale stripe that begins beneath the eye and extends to the forearm; in the other this stripe is present but rather indistinct. This stripe is one of the most characteristic features of *Hyla bicolor*. I did not collect *Hyla bicolor* at Ebor (an insignificant fact, as I collected there for two days only), but it does occur nearby in the Armidale area. The possibility that hybridization occurs in New England should be checked.

When I studied the specimens in the Australian Museum in 1953, there were many identified as *Hyla bicolor* which were really *Hyla phyllochroa*, and they were relabeled accordingly. Two of these (No. 9502) from Cutler's Pass, Williams River, New South Wales, were described subsequently as a new subspecies, *Hyla phyllochroa barringtonensis*, by Copland (1957). The main point of difference seems to be the punctate dorsum in the new subspecies. Copland writes that there are "... about 20 jet black dots the size of pin's heads scattered over the back, but concentrated a little on the head, in the larger specimen, R. 9502A, which is the type. There are four dots on the smaller individual R. 9502B, the paratype." The other characteristics (shape of snout, bulging of the eyes, position of the vomerine teeth) of the new subspecies given by Copland apply equally to the typical subspecies. The new subspecies occurs in the central portion of the range of the typical subspecies.

In my opinion, much more evidence is required before *Hyla phyllochroa barringtonensis* can be considered valid.

GEOGRAPHIC DISTRIBUTION

Hyla phyllochroa occurs in the eastern part of New South Wales and southern Queensland (fig. 42). The southern limit is Bodalla. The type localities are Sydney and Errumanga, New South Wales. I am unable to identify "Errumanga" with any locality within the range of *Hyla phyllochroa*.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Huonbrook (No. 11869)
 Lowana, Dorrigo (Nos. 12637, 12638)
 Cutler's Pass, Williams River (No. 9502)
 Mt. Irvine (No. 12787)
 Woodford, Blue Mountains (Nos. 4345-4348)
 Blue Mountains (No. 4224)
 Killara (No. 4340)
 Lindfield (No. 5850)
 Seven Hills, Parramatta (No. 4478)
 Sydney (No. 5107)
 Stanwell Park Creek (No. 10536)
 Woonoona, near Bulli (No. 4669)
 Burrawang, 20 miles inland from Illawarra
 (Nos. 7384, 7385)
 Kangaroo Valley, Moss Vale district (No. 199)
 Bundanoon (No. 4365)

The American Museum of Natural History has specimens from:

Ebor (Nos. 62524, 62525)
 Grosse River, near Blackheath (Nos. 62526-62532)
 Hamilton (No. 43771)
 Killara (Nos. 62533-62545)
 National Park (Nos. 62546-62549)
 Lawler's Creek, near Bodalla (Nos. 62521-62523)

The British Museum has specimens from:

Mt. Wilson (No. 87.7.16.6)
 Sydney (No. 60.6.19.40, reregistered as 1947.2.24.4;
 No. 63.6.16.84, reregistered as 1947.2.24.3;
 syntypes)
 Errumanga (No. 60.6.19.37, reregistered as
 1947.2.24.5; syntype)
 Burrawang (No. 87.7.16.5)

Additional localities for which there are literature records only are: Dunoon, Richmond River (Fletcher, 1891a).

QUEENSLAND RECORDS

The Australian Museum has a specimen from:

Macpherson Range, 4000 feet (No. 10965; this was received from the Museum of Comparative Zoölogy where it had been labeled *Hyla caerulea*)

The American Museum of Natural History has specimens from:

Binna Burra, Beechmont (Nos. 62550-62552 and five juveniles, Nos. 62553-62557, that are probably this species)

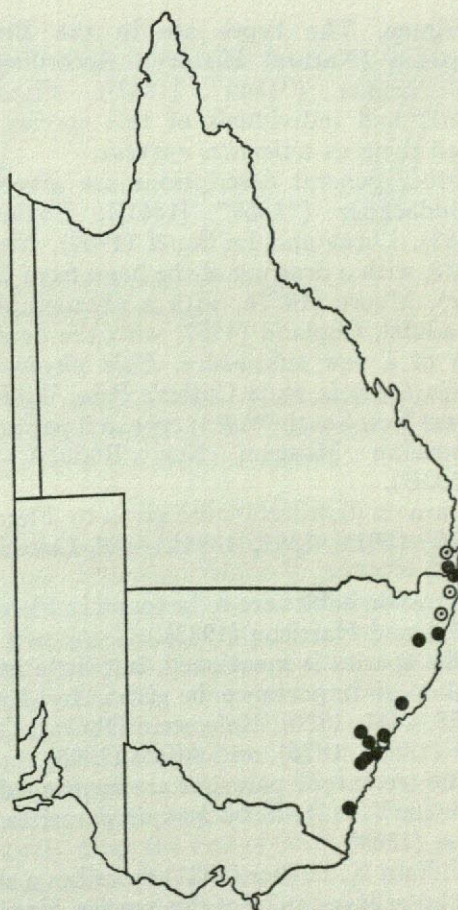


FIG. 42. *Hyla phyllochroa*. Geographic distribution.

Krefft (1856) says that *Hyla phyllochroa* occurs at Brisbane. If so this would be the most northern record for the species.

(NORTHERN TERRITORY RECORDS)

The record of this species for Groote Eylandt (Kingham, 1931) was based on specimens (Australian Museum Nos. 9721-9723) of *Hyla caerulea*. There are no valid records of *Hyla phyllochroa* from the Northern Territory.

LITERATURE

Hyla phyllochroa was described by Günther (1863b, with a drawing of the hand and a fairly accurately colored illustration of the adult) from a living specimen. It was indeed a noteworthy event for one of the early describers of an Australian frog to see a living

specimen. The types are in the British Museum (Natural History). According to Steindachner ("1869" [1867]), Fitzinger (1861) had individuals of this species but listed them as *Calamites cyaneus*.

Other general descriptions are given by Steindachner ("1869" [1867]), Boulenger (1882), Lucas and Le Souëf (1909), Nieden (1923, with a drawing of the hand from Günther), Moore (1957a, with a photograph of an adult), Copland (1957, with the description of a new subspecies, *Hyla phyllochroa barringtonensis*, from Cutler's Pass, Williams River, New South Wales; type and paratype, Australian Museum Nos. R9502A and R9502B).

Data on distribution are given by Fletcher (1890, 1891a, 1892, 1894b) and Loveridge (1935).

Notes on habits are to be found in Fletcher (1889) and Harrison (1922).

The species is mentioned, but little information of importance is given, by Krefft (1865, 1867, 1870), Keferstein (1868a), Günther (1868a, 1876), and Alfalo (1896).

The trematode parasites are mentioned by Johnston (1912); *Batrachomyia* parasites, by Skuse (1889).

William K. Parker (1881) describes a skull that he believed to be of this species. He gives Cape York as the locality for the specimen, so either he had some other species or the specimen was not from Cape York, because *Hyla phyllochroa* appears not to occur north of the Brisbane area in Queensland.

Kinghorn (1931) reported specimens from Groote Eylandt. They are, however, *Hyla caerulea*.

Hyla caerulea (White)

THE GREEN TREE FROG

Plate 41, figure 4; text figures 43, 44

DIAGNOSIS

A combination of the following features separates this species from others in the eastern New South Wales area: large discs on the fingers and toes; dorsal surface leaf green; no brown stripe between nostril and eye; no golden stripe from eye to shoulder; no white stripe below eye; anterior and posterior surface of the thigh pale tan or yellowish green; the skin between the eye and shoulder ele-

vated to form a thick ridge; and a slight web between fingers.

DESCRIPTION

The dorsal surface is usually leaf green in color and without any pattern. At times the color may change to greenish brown. The skin is smooth. Preserved specimens are bluish.

The ventral surface is white, except for the throat, which may be greenish in both males and females. The ventral skin is granular.

The anterior and posterior surface of the thigh is pale tan or yellowish green.

The skin between the eye and shoulder region forms a massive glandular ridge, especially in large individuals. This ridge overhangs the tympanic membrane. There is a ridge on the posterior side of the forearm that is near the junction of the dorsal green area with the ventral white areas. There is a short glandular fold at the posterior end of the jaw, which may be white. The foot has a ridge on both the anterior and posterior borders.

Some individuals have white spots on the back and dorsal surface of the appendages. Usually these are small, about 1 mm. in diameter, and few in number. Occasionally these white areas may be more irregular and several millimeters in extent. The frequency of individuals with white spots seems somewhat greater in the northern part of the species' range. A photograph of a heavily speckled individual is given by Mertens (1958c).

This is a large and stocky species. The largest individual in my collection has a body length of 97.7 mm. It was collected at Rainsby Station, Aramac, Queensland. Copland's (1957) largest specimen is 103 mm. The body proportions of seven specimens from Rainsby Station and Binna Burra, Queensland, which vary in body length from 72.4 to 97.7 mm., are: tibia length/body length, 0.42 ± 0.01 (0.39–0.45); head length/body length, 0.29 ± 0.00 (0.28–0.30); head width/head length, 1.20 ± 0.02 (1.14–1.25).

The tympanic membrane is prominent. Its dorsal edge is overhung by the thick glandular fold that extends from the eye to the level of the forearm.

The fingers have a slight web at the base (fig. 43). The length sequence is $3 > 4 > 2 > 1$.

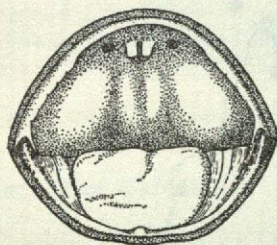


FIG. 43. *Hyla caerulea*. Open mouth, hand, and foot. A.M.N.H. No. 62595. Binna Burra, Beechmont, Queensland.

There are small tubercles on the palm and large ones on the fingers.

The toes have a well-developed web, only the disc and one phalanx of the fourth toe being free (fig. 43.) There are an elongate tubercle at the base of the first toe and a small outer metatarsal tubercle.

The tongue is broad and nicked posteriorly. The vomerine teeth are large. Their anterior margins are between the choanae, but the posterior margins are frequently as much as 2 mm. behind the posterior level of the choanae.

An adult male, after being pithed, secreted a substance from the pores on its head. The secretion resembled, both in consistency and odor, that produced by many species of *Bufo*.

HABITAT

Hyla caerulea is a terrestrial species that is more closely associated with man than is any other Australian frog. During the day it may be found resting in cracks and behind partitions in buildings, especially those near running water. In the drier areas of the continent it is common in the vicinity of water tanks, bathhouses, and toilets. In nature I have found these frogs only in moist places on land, never in ponds or other bodies of water. None of my observations was made, however, during the breeding season.

Fletcher (1889) collected tadpoles in a pond in a grassy paddock. Harrison (1922) has given a long account of this species. It is active only at night. He described it as primarily terrestrial and as going to ponds only to breed.

In Europe *Hyla caerulea* is frequently kept as a pet. Descriptions of its habits in captivity are given by Gadow (1901), Klingelhöffer (1931), Schmidt (1952), and others mentioned below in the literature section.

VOICE

The croaking note of this species is a slow "crawk, crawk, crawk." The interval between each note is about one second.

BREEDING HABITS

I did not observe this species spawning in nature. Claspings, which is pectoral in position, was observed in the laboratory.

Fletcher (1889) never observed breeding in the Sydney area but assumed that this occurred during the summer months. Metamorphosis was observed in March and April. The body length of the young frogs is 17 mm. The tadpoles are green. Males captured in January have nuptial pads. Calling begins shortly after the end of September.

Harrison (1922) found that at Mosman calling began in the middle of October after a heavy rain and was rare after the end of January. Breeding was observed at Mosman on October 16, November 13 and 24, and December 1; at Thirroul on January 3. Eggs deposited early in January near Sydney were transforming tadpoles at the end of February. He gives a vivid account of the movement of the adults to the breeding ponds. Each female deposits a total of between 2000 and 3000 ova, but these are in smaller masses of 100 or 200 ova each. When first laid the ova are in a single layer as a floating surface film. Later the egg masses may sink. The ova are 1.44 mm. in diameter. The animal hemisphere is blackish brown and the vegetal hemisphere yellowish white. Hatching occurs when there are two external gills on each side.

GEOGRAPHIC DISTRIBUTION

Hyla caerulea occurs throughout northern Australia and on the east coast south to the vicinity of Sydney (fig. 44). It occupies a variety of habitats encompassing the range

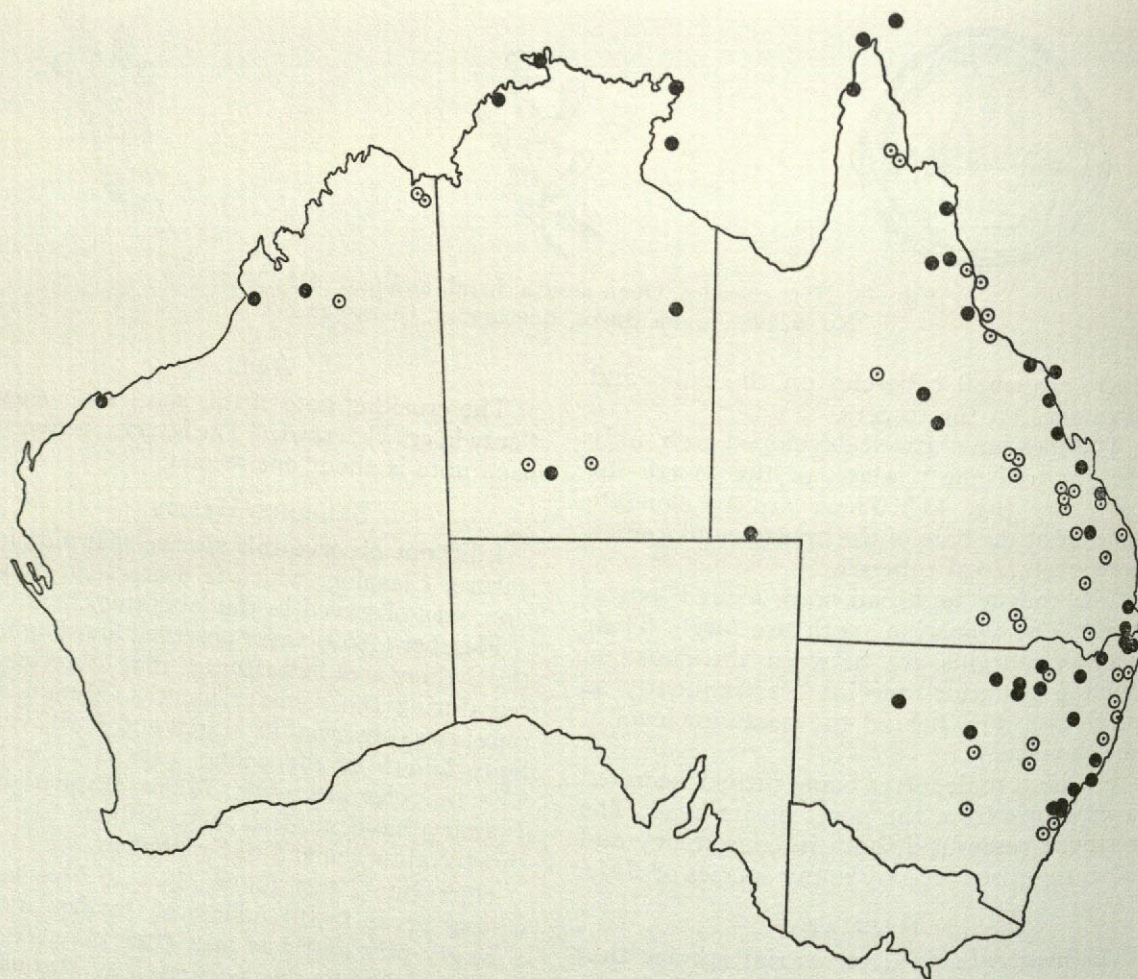


FIG. 44. *Hyla caerulea*. Geographic distribution.

from deserts to rain forests. The type locality is Australia. The specimens first described were undoubtedly from the vicinity of Sydney.

The central Australian representatives of this species were named *Hyla gilleni* by Spencer (1896b). The type locality is Alice Springs. Copland (1957) regards these, as well as the Western Australian individuals, as a subspecies, *Hyla caerulea gilleni*.

Hyla caerulea also occurs in southern New Guinea and possibly in Batanta, which is west of New Guinea (Dunn, 1939). Peters and Doria (1878) list it from localities as far east as Ternate, but these records should be regarded with skepticism.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Tyalgum, Tweed River (No. 11154)
- Dunoon, Richmond River (No. 7464)
- Lismore, Richmond River (No. 5437)
- Tenterfield (Nos. 13125, 13126)
- Bullerana, Moree (No. 11053)
- Inverell (No. 7508)
- Goangra, near Walgett (Nos. 7336, 7338)
- Bearbong, Murrumbidgee (No. 7407)
- Narrabri (No. 7356)
- Pilliga (Nos. 11593, 11594)
- Darling River floods (Nos. 5243-5245)
- The Plains, Nyngan (No. 11781)
- Bulahdelah (No. 8088)
- Ash Island (No. 7074)
- Wyong (No. 11070)
- Upper Colo, via [near] Richmond (Nos. 7972, 7973)
- Sydney (No. 7073)
- Bondi (No. 5092)
- Randwick (No. 5088)
- Waverly (No. 1899)
- Parramatta (Nos. 3833, 4289, 4290)

Smithfield (No. 2826)
 San Souci, Botany Bay (No. 5177)
 Wentworthville (Nos. 9428, 9429)

The American Museum of Natural History has specimens from:

Sydney (Nos. 3824, 6968)

In addition there are two from "Australia" (Nos. 3823, 23978).

The British Museum has specimens from:

Tamworth (No. 96.7.1.36)

Sydney (No. 64.7.9.15)

Additional New South Wales records from the literature are Illawarra, Coolah on the Talbragar, Guntawang near Mudgee, and Dandaloo on the Bogan (Fletcher, 1890); Maclean on the lower Clarence and Ulmarra to Chatsworth on the lower Clarence (Fletcher, 1894b); Bundy and Ulong (Slevin, 1955) Yarramalong, Fitzroy Falls (the most southern record), Horton's Creek 7 miles west of Grafton, Nettle Creek 12 miles from Copmanhurst, Failford near Tuncurry, West Wyalong, *Glenelg, and Nambucca Heads (Copland, 1957); and Comboyne Plateau (Chisholm, 1925).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Murray Island, Torres Strait (Nos. 4520-4524, 5355, 9680)

Moa Island, Torres Strait (No. 7930)

Thursday Island, Torres Strait (Nos. 9658-9663)

Mapoon, Gulf of Carpentaria (No. 3538)

22 miles inland from Cairns (No. 223)

Almaden (Nos. 9621, 11319)

Herbert River (Nos. 6648, 6649)

Port Denison (No. 7069)

Lindeman Island (Nos. 11161, 11361, 11706)

*Sylvania, central north Queensland (Nos. 6522-6524)

Rockhampton (No. 7077)

Gladstone (No. 4320)

Eidsvold, Burnett River (Nos. 6115, 6328-6330)

The American Museum of Natural History has specimens from:

Mer, Murray Islands, Torres Strait (No. 6734)

Kamerunga, near Cairns (No. 54690)

Rainsby Station, near Aramac (Nos. 62597-62601)

St. Lawrence (Nos. 62602-62606, juveniles)

Birdsville area (No. 49875)

Binna Burra, Beechmont (Nos. 62595, 62596)

The British Museum has specimens from:

Murray Islands (No. 78.10.16.91)

Thursday Island (No. 81.10.12.5)

Mer Island (Nos. 90.1.14.22-90.1.14.24)

Near Cooktown (No. 1903.10.19.38)

Port Mackay (No. 85.9.2.49)

Torrens Creek (No. 1926.2.25.13)

Moreton Bay (No. 58.10.30.1)

"Queensland" (No. 92.6.21.12)

Additional Queensland records from the literature are Townsville, Coen, Towri Station near Richmond (Loveridge, 1935); Coomoolooloo near Duaringa, Talafa near Emerald, Margenta near Retro, Retro, Koolonga Creek, near Gin Gin, and Noondoo near Dirranbandi (Slevin, 1955); Stewart River at Princess Charlotte Bay (Kinghorn, 1935); Karara, Bollon, Jandowae, Winderah (=Winderah), 34 miles west of Eidsvold, Moura, Baralaba, 23 miles south of Wowan, Calliope, St. George, Dunk Island, Palm Island, and Capella (Copland, 1957); Carriington (Andersson, 1916); and Innisfail (Mertens, 1958b).

NORTHERN TERRITORY RECORDS

The Australian Museum has specimens from:

Cape Arnhem (No. 13645)

Port Darwin (Nos. 4909, 8243, 12900)

Yerrikala, via [near] Darwin (Nos. 12400-12403)

Groote Eylandt (Nos. 9721-9723, 10193, 11021, 13628)

The American Museum of Natural History has a specimen from:

Darwin vicinity (No. 43836)

The British Museum has specimens from:

Port Essington (Nos. 44.10.17.20, 42.2.24.10, 1847.7.21.46)

Port Darwin (No. 84.9.13.27)

Groote Eylandt (No. 1926.2.25.14)

Alexandria (Nos. 1906.3.31.21, 1908.2.25.37, 1908.2.25.38)

North Australia (No. 58.4.20.60)

Hermansburg (Nos. 1907.10.30.1, 1910.5.28.36; both listed as *Hyla gilleni*)

Additional Northern Territory records reported in the literature are Palm Creek near Alice Springs (Loveridge, 1949); Alice Springs, and Telipata Gorge in the western Macdonnell Range (Copland, 1957). All these

are in the range of *Hyla caerulea gilleni* (Copland, 1957).

WESTERN AUSTRALIA RECORDS

The Australian Museum has a specimen from:

*Kimberley district (No. 6984)

The British Museum has specimens from:

Liveringa Station, Fitzroy River (Nos. 1952.1.1.6-1952.1.1.8)

Roebuck Bay (No. 96.7.2.20)

Nicol Bay (No. 67.2.19.55)

Additional records from the literature, all of which would be *Hyla caerulea gilleni* according to Copland (1957), are Carlton Reach on the Ord River, Ivanhoe Station on the Ord River (Copland, 1957); and at the junction of the Fitzroy River and Margaret Creek (Fletcher, 1898).

LITERATURE

The first description of *Hyla caerulea* appears to be in John White (1790) under the name *Rana caerulea*. A crude illustration accompanies the description. Probably the description was the work of Shaw, although such is not explicitly stated, so I feel it is proper to consider the author named on the title page of the publications as the describer. *Hyla caerulea* was the first Australian frog to be described.

Other descriptions are given by Schlegel (1837-1844, as *Hyla cyanea*, with a figure of the adult in color), Duméril and Bibron (1841, 1854, as *Hyla cyanea*), Günther (1858, as *Pelodryas caeruleus*, with an illustration of an adult and the hand; 1863b, also as *P. caeruleus*), Keferstein (1868a, as *P. caeruleus*, with a figure of the skull), Steindachner ("1869" [1867], as *Calamites cyaneus*), Krefft (1870, as *Pelodryas caeruleus*), Boulenger (1882), Boettger (1894), Lucas and Le Souëf (1909, with a photograph of an adult), Barbour (1914), Richard Deckert (1915, with a photograph of an adult), Nieden (1923), van Kampen (1923), Loveridge (1935), Slevin (1955), Moore (1957a, with a photograph of an adult), and Copland (1957, who recognizes *Hyla caerulea gilleni* as a distinct subspecies).

Boulenger (1912) compares this species with *Hyla infrafrenata* and gives numerous measurements of both.

Spencer (1896b, with drawings of the adult, head, hand, and foot) describes as new *Hyla gilleni* from Alice Springs. The relation of this to *Hyla caerulea* has not been settled. Copland (1957) and Mertens (1958a) regard it as a subspecies. Mertens (1958c) provides a photograph of an adult with many white specks.

Fry (1912) believes that *Hyla irrorata* de Vis is *Hyla caerulea*.

References that deal primarily with distribution are Gray (1842), Günther (1867, as *Pelodryas caeruleus*), Peters and Doria (1878, as *P. caerulea*), Fletcher (1890, 1891a, 1894b, 1898), Garman (1901), Fry (1914), Anderson (1916), Chisholm (1925), Burt and Burt (1932), Kinghorn (1935), and Loveridge (1938, 1949).

References dealing primarily with habits, usually of captive individuals, are Günther (1863b), Krefft (1863, as *Pelodryas caerulea*), Fischer (1883), Fletcher (1889), Lorenz Müller (1901, with a drawing of the adult), Gadow (1901, with a drawing of the adult), Roth (1908), Lankes (1909, 1928), Richard Deckert (1915), Harrison (1922), Klingelhöffer (1931, 1956, with photographs of the adult), and Schmidt (1952, with a photograph of two adults).

Various descriptions are given, as follows: of the depressor mandibulae muscle, by Griffiths (1954); of death from tuberculosis, by W. C. O. Hill (1954); of the trematode parasites, by Johnston (1912); of the scapula, by Procter (1921); of the hyoid and larynx, by Trewavas (1933); of the skull, by William K. Parker (1881, as *Pelodryas cerulaeus*); of the vertebrae, by Nicholls (1916); of the pectoral girdle, vertebral column, and skull, by Gillies and Peberdy (1917a, 1917b); of the masticatory and branchial muscles of the tadpole, by Kesteven (1944); of the movement of blood through the heart and major arteries, by Simons and Michaelis (1953); and of a *Batrachomyia* parasite, by Lindner (1958), Mertens (1958b), and Franz (1958).

The species is briefly mentioned by Schneider (1799, as *Rana austrasiae*), Shaw (1802, as *Rana caerulea*), Daudin ("An. XI" [1802], as *Hyla cyanea* and "An. XI" [1803?], as *Rana coerulea*), Merrem (1820, as *Rana caerulea*), Fitzinger (1826, 1843, as *Calamita cyanea*), Wagler (1830, as *Calamites coerulea*),

Gray (1841a), Duméril (1853, as "rainette de bleue"; 1865), Girard (1859, as *Hyla cyanea*), Krefft (1862, 1865, 1867, as *Pelodryas caeruleus*), Cope (1867, as *Calamita cyanea* and *Calamita cyaneus*), Macleay (1877, as *Pelodryas caeruleus*), Anonymous (1883), Fletcher (1892), Boettger (1892, 1901, as *Pelodryas caerulea* and *Hyla caerulea*), Aflalo (1896), van Kampen (1909), Andersson (1913a), Roux (1920), Smith (1929), Noble (1931), Mandeville (1952), Scortecci (1953), and Mertens (1958a).

Fitzinger (1861) equated it with *Auletris jacksoniensis*, which at the present time is thought to be *Hyla aurea*.

***Hyla chloris* Boulenger**

THE NORTH COAST GREEN TREE FROG

Plate 42, figure 2; text figures 45, 46

DIAGNOSIS

A combination of the following characters separates this species from all others in eastern New South Wales: large discs on fingers and toes; dorsal surface uniformly green and without distinctive markings on the head; canthus rounded; inner half of the dorsal surface of the hand unpigmented; dorsal surface of the proximal segment of the arm only partly pigmented; well-developed web between the fingers.

DESCRIPTION

There is little that is distinctive about this species. The entire dorsal surface, apart from the two inner fingers and the three inner toes, is leaf green. (In preserved specimens this color changes to blue.) In addition, the proximal segment of the arm is not fully pigmented. The color of the posterior surface of

the thigh is purplish. The skin of the dorsal surface is smooth.

The ventral surface is colorless, except for the edge of the lower jaw, which is green. The skin of the chest and abdomen is granular.

This is a medium-sized and broad-headed species. The maximum body length is 65 mm. The body proportion ratios of eight individuals from Dunoon, Richmond River, New South Wales (Australian Museum Nos. 7484-7491), which vary in body length from 52.7 to 60.5 mm., are: tibia length/body length, 0.52 ± 0.00 (0.51-0.53); head length/body length, 0.32 ± 0.00 (0.31-0.34); head width/head length, 1.12 ± 0.00 (1.10-1.13). Measurements made on the type specimen are: body length, 60.5 mm.; tibia length, 31.5 mm.; head length, 19.6 mm.; head width, 21.0 mm.

The tympanic membrane is distinct. A faint fold in the skin extends from the posterior border of the eye across the dorsal edge of the tympanic membrane. The canthus is rounded, and this feature is important in distinguishing *Hyla chloris* from *Hyla gracilentia*.

The fingers have a well-developed web; the disc and half of one phalanx of the third finger are free (fig. 45). The sequence in length is $3 > 4 > 2 > 1$.

The toes also have a well-developed web; the disc and one phalanx of the fourth toe are free (fig. 45). There is a prominent inner metatarsal tubercle.

The tongue is broad. The posterior edge of the vomerine teeth is behind the level of the choanae. The anterior edge is at the level of the middle of the choanae (fig. 45).

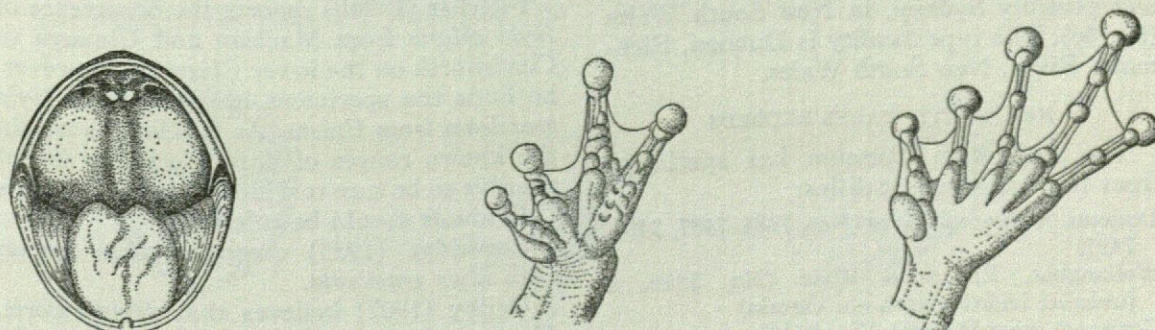


FIG. 45. *Hyla chloris*. Open mouth, hand, and foot. A.M.N.H. No. 62910. Dunoon, Richmond River, New South Wales.

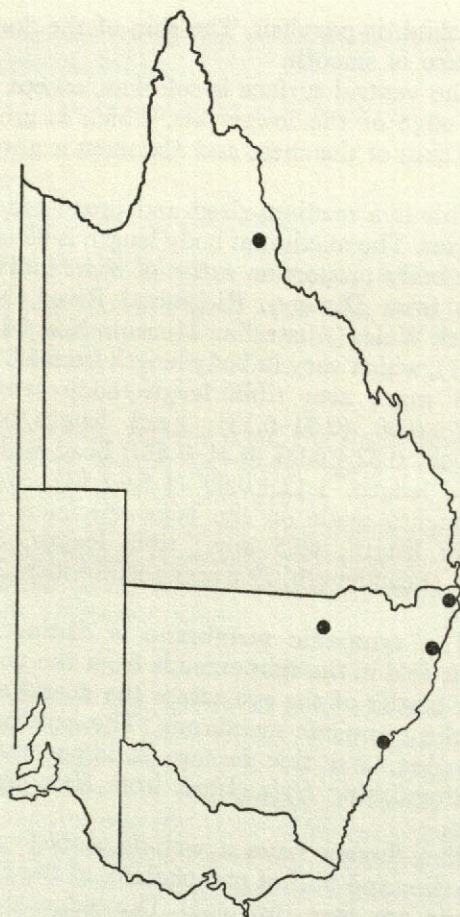


FIG. 46. *Hyla chloris*. Geographic distribution.

FIELD OBSERVATIONS

There are none.

GEOGRAPHIC DISTRIBUTION

Hyla chloris is found in eastern Australia from northern Queensland south to Gosford, and possibly Sydney, in New South Wales (fig. 46). The type locality is Dunoon, Richmond River, New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from the following localities:

- Dunoon, Richmond River (Nos. 7484-7487, 7490, 7491)
- Wollongbar, Richmond River (No. 5846; a juvenile; identification not certain)
- Goangara, near Walgett (No. 7339)
- Lowana, Dorrigo (Nos. 12635, 12636, 12743)
- Gosford (No. 9902)

The Goangara locality is somewhat of a surprise. I identified the specimen from there as *Hyla chloris*, and Copland (1957) agrees. This record should be questioned, unless additional specimens are secured.

The American Museum of Natural History has specimens from:

- Dunoon, Richmond River (Nos. 62909, 62910, originally Nos. 7488, 7489 of the Australian Museum)
- Sydney (No. 23746)

The specimen from Sydney is very old; it was collected by Kirchner in 1847, and received from the Senckenberg Museum (as *Hyla gracilentia*). This record is the only one as far south as Sydney, and it should be questioned. It is not shown on the distribution map.

The British Museum (Natural History) has a single specimen, the type:

- Dunoon, Richmond River (No. 92.9.16.10, re-catalogued as 1947.2.23.86)

QUEENSLAND RECORDS

The American Museum has specimens from:

- Vine Creek, Ravenshoe (No. 19939)
- Maalan Sutties Gap Road, 12 miles south of Millaa Millaa (No. 54176)

LITERATURE

Hyla chloris was described by Boulenger (1893) on the basis of a specimen sent to him by Fletcher. The type is in the British Museum (Natural History). Fletcher (1891a) obtained living individuals of this species and described it, using the name *Hyla gracilentia*. Nieden (1923) also gives a description.

Fletcher (1894b) reports the occurrence of *Hyla chloris* from Maclean and Ulmarra to Chatsworth on the lower Clarence. However, he finds the specimens identical with *Hyla gracilentia* from Cairns. As Maclean is within the known ranges of both species, it is not possible to be sure to which species Fletcher's individuals should be referred.

Loveridge (1935) compares this species with *Hyla gracilentia*.

Ogilby (1907) believes that *Hyla chloris*, *Hyla gracilentia*, and *Hyla luteiventris* might be "looked upon as varieties of a single species." Fry (1912) is of the same opinion.

Hyla gracilentia Peters
THE DAINTY GREEN TREE FROG
Plate 41, figure 3; text figures 47, 48

DIAGNOSIS

A combination of the following characteristics separates this species from all others in eastern New South Wales: large discs on the fingers and toes; well-developed webs between the fingers; dorsal surface of the head and trunk leaf green; canthus angular; dorsal surface of the upper arm and thigh straw yellow; dorsal surface of the hand, except for the outer edge of the fourth finger, also straw-colored.

DESCRIPTION

This is a beautiful little *Hyla*. The dorsal surface is a pale leaf green. In some individuals a faint golden line extends from the nose along the upper eyelid and across the top of the tympanum. This is similar to the much better-developed line of *Hyla phyllorchroa*. The dorsal surface of the upper arm is straw yellow. One of the most distinctive features is the coloration of the forearm, which has an elongate green zone that occupies most of the dorsal surface. This island of green is sharply delimited from the straw yellow background. The entire dorsal surface of the hand is straw yellow, except for an occasional individual that has a green edge to the fourth finger. The eye is bronze. The dorsal surface is smooth.

The thigh has no green. The anterior and dorsal surfaces are yellowish, and the posterior surface is brownish. The dorsal surface of the tibial section of the leg and the foot is green. The foot has a distinct white line on its outer edge.

The sides of the body are yellowish. The

ventral surface is pale yellow and finely granular.

This is a small and moderately proportioned *Hyla*. The largest specimen that I have seen is 44 mm. in body length. A male 28.5 mm. in body length had a well-developed vocal sac. Andersson (1916) mentions a specimen from Malanda, Queensland, that has a body length of 56 mm. This is far larger than any I have seen and is the size of the similar *Hyla chloris*. The body proportion ratios of the six specimens in the British Museum (Natural History) and three from the American Museum of Natural History, which vary in body lengths from 29.6 to 38.7 mm., are: tibia length/body length, 0.53 ± 0.00 (0.50–0.55); head width/head length, 1.08 ± 0.02 (1.02–1.14); head length/body length, 0.32 ± 0.01 (0.30–0.36).

The tympanic membrane is distinct.

The fingers have moderately developed discs and a well-developed web; the disc and one phalanx of the third finger are free (fig. 47). The length sequence is $3 > 4 > 2 > 1$.

The toes have moderately developed discs and webs; the disc and one phalanx of the fourth toe are free (fig. 47).

The tongue is broad, circular, and nicked posteriorly (fig. 47).

The vomerine teeth are flattened. Their posterior edges project slightly behind the level of the choanae.

Specimen No. 6253 in the Muséum National d'Histoire Naturelle in Paris is labeled "*Hyla gracilentia*, Peters. Type Australie. British Mus." [see Guibé, (1950?)]. The colors are still good. Measurements are as follows: body length, 35.5 mm.; tibia length, 19.7 mm.; head length, 13.2 mm.; head width, 13.3 mm.

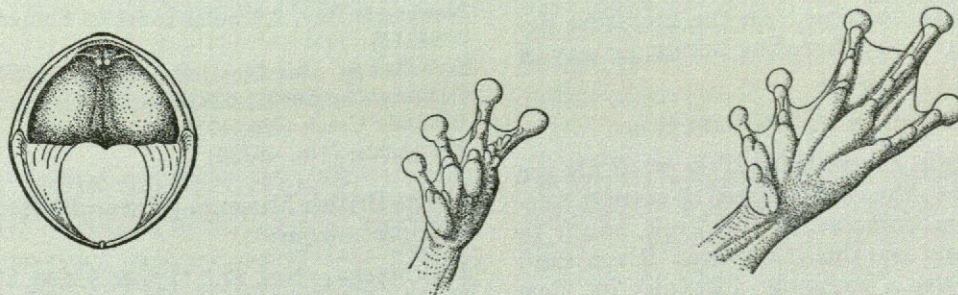


FIG. 47. *Hyla gracilentia*. Open mouth, hand, and foot.
A.M.N.H. No. 40304. Ravenshoe, Queensland.

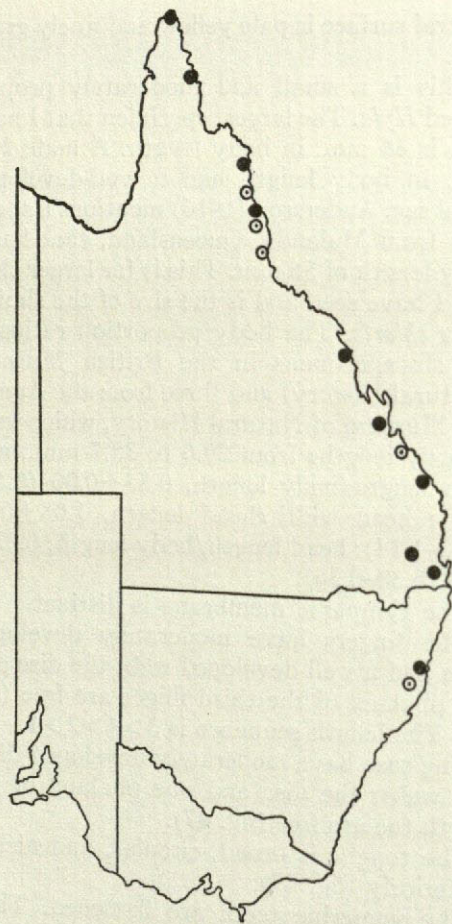


FIG. 48. *Hyla gracilentia*. Geographic distribution.

HABITAT

My only field observations on *Hyla gracilentia* were made near Cairns, Queensland. A single individual was found sitting on the vegetation bordering a sluggish stream in which many lily pads and other vegetation were growing.

There are no records in the literature describing its voice, breeding habits, or way of life.

GEOGRAPHIC DISTRIBUTION

The locality records for *Hyla gracilentia* are restricted to the coastal areas of eastern Australia from Somerset, Cape York, south to Gurravembi on the Nambucca River (and possibly the Comboyne Plateau) in New South Wales (fig. 48). The type locality is Port Macquarie, Queensland.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Gurravembi, Nambucca River (Nos. 6186; 6311-6317)

*Far north coast (No. 13253, three individuals)

*New South Wales (No. 12492, three individuals)

The American Museum of Natural History has specimens from:

Gurravembi, Nambucca River (Nos. 62911, 62912, formerly Nos. 6309, 6310 of the Australian Museum)

Sydney (No. 6966)

I doubt the accuracy of the Sydney locality and have not shown it on the distribution map.

One locality given in the literature is the Comboyne Plateau (Chisholm, 1929); it is the southernmost record. Fletcher (1891a) mentions specimens from Dunoon (later described as *Hyla chloris* by Boulenger) and Grafton. The latter locality may be correct, but, inasmuch as Fletcher did not differentiate *Hyla chloris* and *Hyla gracilentia* in 1891, I am not accepting the record.

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Cooktown (No. 3964)

*Herbert River, north Queensland (No. 6656)

Isis Scrub (No. 6953)

Crow's Nest (Nos. 2597, 2637)

Brisbane (No. 4379, cotype of *Hyla luteiventris*; Nos. 5015, 5251)

*Queensland (No. 5513)

The American Museum of Natural History has specimens from:

Newcastle Bay, 2.5 miles south of Somerset (No. 54213)

Iron Range, near Lloyd Bay (Nos. 54257, 54259)

Cairns (Nos. 54691, 62913)

Babinda Creek (No. 40303)

Ravenshoe (No. 40304)

The British Museum (Natural History) has specimens from:

Port Mackay (Nos. 82.7.17.8, 85.9.2.44, 85.9.2.45)

Rockhampton (Nos. 74.8.11.20-74.8.11.22, re-catalogued as 1947.2.23.89-1947.2.23.91; types of *Hyla fordii*)

Literature records are Malanda, Carrington (Andersson, 1916); Mossman, *Landkelly Creek, Lake Barrine (Loveridge, 1935); and Cardwell and Calliope (Copland, 1957).

LITERATURE

Hyla gracilentia was described by Peters (1869) on material from Port Mackay, Queensland. Other descriptions are to be found in Boulenger (1882), Lucas and Le Souëf (1909), Nieden (1923), and Copland (1957).

Hyla luteiventris was described by Ogilby (1907) as a new species, but he suggested that it could be regarded as a variety of *Hyla gracilentia*. The type locality is Brisbane. Nieden (1923) accepted it as a valid species. Fry (1912) and Loveridge (1935) thought it was *Hyla gracilentia*. A cotype of *Hyla luteiventris* is in the Australian Museum (No. 4379); it is a typical *Hyla gracilentia*.

Hyla fordii of Günther (1876) was identified as *Hyla gracilentia* by Boulenger (1882). The type locality is Rockhampton. The types (Nos. 74.8.11.20–74.8.11.22, recatalogued as 1947.2.23.89–1947.2.23.91) are still in the British Museum (Natural History); they are typical *Hyla gracilentia*.

Pelodryas granulata of Peters (1873a) from Port Bowen is probably *Hyla gracilentia*, according to Boulenger (1882).

Fletcher (1894b) seems (his remarks are confusing) to consider *Hyla chloris* and *Hyla gracilentia* as conspecific. Fry (1912) is of the same opinion.

Papers that give little more than geographical data are by Fletcher (1891a), Boettger (1892), Garman (1901), Roth (1908), Andersson (1916), and Chisholm (1929).

Minor mention is made by Fletcher (1892), Aflalo (1896), and Mertens (1958a).

The citation of this species from Dunoon by Fletcher (1891a) is based on individuals that were subsequently described as *Hyla chloris* by Boulenger (1893).

THE GREEN HYLAS

In eastern Australia there are six species of green tree frogs that are superficially similar to one another. They are predominantly leaf green above and white or pale below. The head is rounded. The identification of them is

often difficult, so some general remarks on the group as a whole are made.

In the Sydney region there are three, namely, *Hyla bicolor*, *Hyla phyllochroa*, and *Hyla caerulea*. Two others, *Hyla chloris* and *Hyla gracilentia*, reach their southern limits somewhat north of Sydney. A sixth species, *Hyla infrafrenata*, is found only in northern Queensland and in New Guinea and adjacent islands. Except for *Hyla caerulea*, these species are restricted to the areas near the coast.

In spite of the superficial resemblances of these six species, each can be recognized by a single character or a combination of several (see key). The characters important in identification are: the presence or absence of vomerine teeth; the extent of the web between the fingers; the presence or absence of markings on the head; the color of the proximal segment of the arm; the color of the hand; and the color of the thigh.

Vomerine teeth are always absent in *Hyla bicolor* (many years ago this species was placed in a separate genus, *Hylella*, which was defined as *Hyla* without vomerine teeth). *Hyla phyllochroa* usually has vomerine teeth, but some individuals lack them on one side, and others lack them entirely. The other four species of green hylas have well-developed vomerine teeth.

The web between the fingers is well developed in *Hyla chloris* and *Hyla gracilentia* in which it reaches or almost reaches the disc of the fourth finger. In *Hyla infrafrenata* the web extends halfway to the end of the fourth finger. The remaining species, *Hyla bicolor*, *Hyla phyllochroa*, and *Hyla caerulea*, have only a minute web between the fingers.

The distinctive markings on the head consist of horizontal stripes on the upper jaw, lower jaw, or along the canthus. *Hyla bicolor* has a pale stripe that begins on the edge of the upper jaw, at the level of the eye, and extends at least to the level of the arm and sometimes farther along the flank. *Hyla phyllochroa* has a golden line that extends from the nostril to the eye and from the eye across the top of the tympanic membrane to the shoulder. Some individuals of *Hyla gracilentia* may have a poorly developed golden stripe in a similar position. In *Hyla infrafrenata* there is a light line extending along the edge of the lower jaw posterior to the forearm. *Hyla caerulea*, *Hyla*

chloris, and, in most cases, *Hyla gracilentia* lack distinctive markings on the head. In *Hyla caerulea* the skin behind the eye forms a curving ridge that overlaps the tympanic membrane. *Hyla infrafrenata* has a similar ridge, but it is not well developed.

The dorsal surface of the upper arm is largely green in all the species except *Hyla gracilentia*, *Hyla chloris*, and *Hyla bicolor*. In *Hyla chloris* and *Hyla bicolor* it always has some green, but in *Hyla gracilentia* it is entirely yellowish. The green is also much reduced on the forearm of *Hyla gracilentia*, in which it forms a sharply delimited oval area.

The dorsal surface of the hand of *Hyla gracilentia* and *Hyla chloris* has little or no green. *Hyla gracilentia* usually has less than *Hyla chloris*, as it is restricted to the outer edge of the fourth finger. *Hyla chloris* usually has a green fourth finger, and in some individuals the third is also green.

The color of the thighs is useful in the identifying of living individuals. The posterior surface of the thigh is orange in *Hyla bicolor*, brick red in *Hyla phyllochroa*, and tan in *Hyla caerulea*—the three species found in the Sydney region. The thigh of *Hyla gracilentia* is unique in having no green. The anterior and dorsal surfaces are yellowish, and the posterior surface is brownish. In *Hyla chloris* the dorsal surface of the thigh usually has some green, and the posterior surface is purplish. In some cases *Hyla infrafrenata* has a prominent pale yellow stripe (with tiny brick red dots) on the posterior surface of the tibia.

The only species that are difficult to distinguish from each other are *Hyla chloris* and *Hyla gracilentia*. The differences mentioned above in the coloration of the hand, forearm, upper arm, and thigh are usually sufficient. The differences in the size of mature individuals are considerable, *Hyla chloris* reaching a maximum size of 65 mm. and *Hyla gracilentia* 44 mm. The most useful characters for separation are the shape of the snout and of the canthus. In *Hyla gracilentia* the canthus is angular and in some specimens lighter in color than the rest of the head. When the head is viewed from the side, the snout appears angular, the nostril being at the intersection of the canthus and the horizontal line formed by the tip of the snout. In *Hyla chloris* the canthus is more rounded. When

the snout is viewed from the side, it appears rounded, and the nostril is not so far forward as in *Hyla gracilentia*.

Hyla infrafrenata (pl. 42, fig. 1) is found only in northern Queensland so far as the mainland is concerned. It occurs also in New Guinea and on many of the smaller islands. This pattern of distribution suggests that it is a recent invader of Australia. It is certainly the largest *Hyla* in Australia and possibly in the world. It is probably the largest native Australian amphibian (the introduced *Bufo marinus* is larger). The largest specimen that I have seen, which is from Goodenough Island, is 129 mm. in body length (A.M.N.H. No. 58682).

Hyla peroni (Tschudi)

PERON'S TREE FROG

Plate 43, figure 2; text figures 49, 50

DIAGNOSIS

The possession of the following features serves to distinguish this species from others in eastern New South Wales: well-developed discs on the fingers and toes; second finger noticeably longer than first; hind surface of thigh with yellow and black vermiculations.

DESCRIPTION

The color of this species is quite changeable, as is the case with so many other species of *Hyla*. Most of the individuals I collected were brownish above, with irregular mottlings, or tan, but a few were light gray. In captivity they are generally a pale lichen gray. The dorsal surface is without a prominent pattern. Most specimens have some tiny blue-green spots on the back. In a few specimens there is a faint suggestion of the "ewingi pattern" on the back, i.e., a broad band, somewhat darker than the lateral areas, beginning behind the eyes, narrowing in the shoulder area, and then widening to cover nearly the entire back. The skin of the back is slightly rough.

The most conspicuous feature of *Hyla peroni* is the yellow and black vermiculation of the posterior surface of the thigh. In some individuals the groin, side, and armpit are similarly colored. Individuals from western New South Wales have the relative amount of yellow increased and of black decreased.

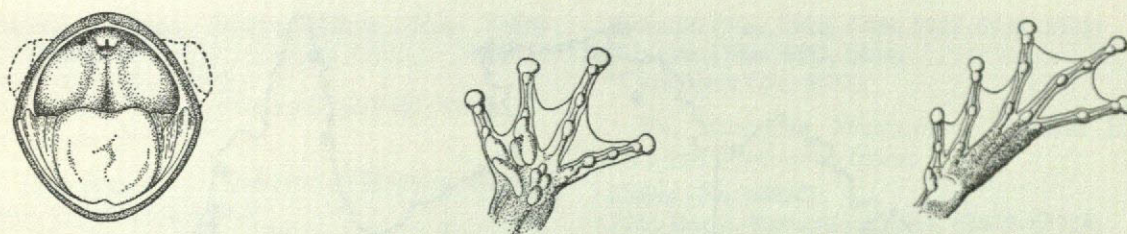


FIG. 49. *Hyla peroni*. Open mouth, hand, and foot. A.M.N.H. No. 63813. Ebor, New South Wales.

In some north Queensland individuals the yellow forms more or less regular spots, each surrounded by a black ring.

The chest and belly are white and slightly granular. The anterior part of the throat may be dark in both sexes. In males the posterior half of the throat, where the vocal sac protrudes, is yellowish. There is a well-developed chest fold.

This is a medium-sized species with a moderately broad head. The largest individual that I have seen is a female 65 mm. in body length (A.M.N.H. No. 63807). It was collected at Wahroonga, New South Wales. Four males from Ebor, New South Wales, and six males from Binna Burra, Queensland, collected at night when they were calling, were used to determine the body proportions. These 10 individuals vary from 43.6 to 58.4 mm. in body length. The ratios are as follows: tibia length/body length, 0.51 ± 0.00 (0.48–0.52); head length/body length, 0.31 ± 0.00 (0.30–0.33); head width/head length, 1.00 ± 0.01 (0.95–1.06). The head width/head length ratios of the four Ebor males varied from 1.01 to 1.06, while in the six Binna Burra males the range was 0.95 to 0.97. Too much should not be made of this difference found in such small series, but it might be kept in mind by persons who may study large numbers of specimens.

The following measurements were made on the type, No. 4809 in the Muséum National d'Histoire Naturelle in Paris: body length, 52.7 mm.; tibia length, 25.6 mm.; head length, 16.1 mm.; head width, 16.4 mm.

The eye is golden, with a dark vertical and a dark horizontal stripe that form a cross centering at the pupil.

The tympanic membrane is well developed. The skin above it forms a slight overhanging ridge.

The fingers are webbed; the disc and one phalanx of the third finger are free (fig. 49). The sequence of finger lengths is $3 > 4 > 2 > 1$. The male has a nuptial pad on the thumb.

The toes are webbed; the disc and one phalanx of the fourth toe are free (fig. 49). There is an inner metatarsal tubercle.

The tongue is broad and has a slight posterior nick (fig. 49). The vomerine teeth are between the choanae. Their anterior borders are at the level of the anterior edge of the choanae.

HABITAT

Hyla peroni was observed in a variety of habits. Males were calling while sitting on logs and rocks, as well as on the ground, by Guy Fawkes Creek (pl. 28, fig. 1) at Ebor, New South Wales, on November 20, 1952. Males were also found calling in a swamp (pl. 32, fig. 1) at Binna Burra, Queensland, December 15–21, 1952. I did not collect it at Killara, New South Wales, but heard it calling.

VOICE

Males at Ebor, New South Wales, were noted as having a very loud whirring call, "wr wr wr wr." Each "wr" is distinct. The call lasts about three seconds.

To Harrison (1922) this species seemed to be saying "cook-cook, cook, cook-cook, cook, cook."

Richard Deckert (1915) wrote that the "call resembles the voice of the pneumatic drill used by structural iron workers, and might be described as a loud, metallic rattling."

BREEDING HABITS

I did not encounter this species when it was breeding.

Fletcher (1889) seems not to have observed

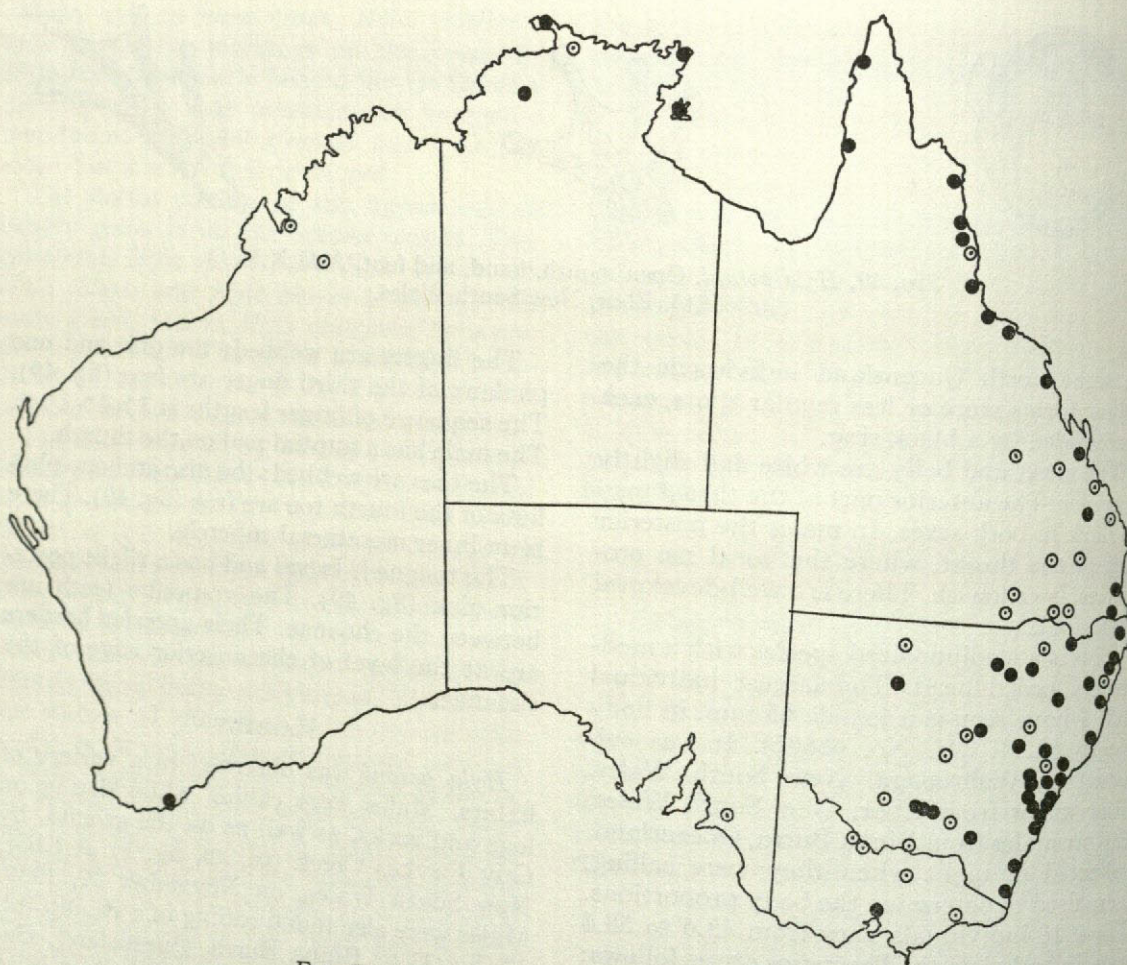


FIG. 50. *Hyla peroni*. Geographic distribution.

breeding, but mentions that it begins late. The fully grown tadpole has a total length of 61 mm., and the body is 21 mm. long.

Harrison (1922) found this species calling in December at Gordon, and in January at Thirroul, New South Wales.

GEOGRAPHIC DISTRIBUTION

Hyla peroni is widely distributed in Australia (fig. 50) apart from the interior regions. It occurs in all the mainland states. There is no reason to believe that it occurs in Tasmania, despite a century's discussion of the possibility. The type locality is "Australia."

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Richmond River (No. 1242)
Jaffa, Ashford Downs (No. 9408)
Lower Clarence River (Nos. 7528-7530)
Goangra, near Walgett (Nos. 7340, 7341)

Pillaga (Nos. 11600-11602)
Darling River floods (Nos. 4295-4298)
Warrell Creek, Nambucca River (No. 4253)
Narrabri (Nos. 7358-7362)
Lowana (No. 12744)
Nambucca River (No. 5895)
Buddah Lakes, Trangie (Nos. 5443-5445)
Bulahdelah (Nos. 8092, 8093)
East Maitland (No. 6543)
Bowenfels South (Nos. 13387, 13388)
Palmdale, Wyong (Nos. 12078, 12079)
Mt. Wilson (No. 7472)
Upper Colo, via [near] Richmond (Nos. 7964, 7966, 7967)
Parramatta (Nos. 3838, 4633, 4634)
Mulgoa (No. A 7116)
Marrickville (No. 3385)
Coolong, via [near] Yerranderie (Nos. 9394-9396)
Woonoona, near Bulli (Nos. 4662, 4663)
Yanco (Nos. 10696-10716, 10718-10725)
Emu Plains, Urana, 18 miles from Narrandera (Nos. 7345, 7346)
10 miles west of Narrandera (Nos. 10694, 10695)

Tubbo Station, Murrumbidgee (Nos. 10690-19693)
 Colo Vale (No. 1870)
 Mt. Horeb, Tumut district (Nos. 8347, 8348)
 Pambula (No. 2399)

The American Museum of Natural History has specimens from:

Ebor (Nos. 63811-63814)
 Tamworth (No. 13333)
 Capertee (Nos. 63808-63810)
 Wahroonga (No. 63807)
 Canley Vale (No. 63818)
 Parramatta (Nos. 23913, 23914)
 Bulli (No. 13334)
 Gerroa (Nos. 63815, 63816)
 Bodalla (No. 63817)
 *New South Wales (No. 23912)
 *Sydney? (No. 63808)

The British Museum (Natural History) has specimens from:

Clarence River (No. 63.6.16.97)
 Guntawang, near Mudgee (No. 88.7.3.22)
 Sydney (Nos. 63.6.16.78, 63.6.16.79)
 Botany Bay (Nos. 1924.2.27.11, 1924.2.27.12)
 Long Bay, near Sydney (No. 79.5.26.27)
 Nowra (Nos. 1925.4.29.2, 1927.4.1.1)
 *New South Wales (No. 70.6.26.26)

Additional localities for which there are literature records are: Coolah on the Talbragar, Dandaloo on the Bogan, Hay and Wagga on the Murrumbidgee (Fletcher, 1890); Kiaccatoo Station on the Lachlan, 20 miles below Condobolin (Fletcher, 1891a); Bundy and Ulong (Slevin, 1955); and Putty, Tocumwal, and Poison Point Bore 53 miles west of Bourke (Copland, 1957).

VICTORIA RECORDS

The American Museum of Natural History has a specimen from:

Coburg, north of Melbourne (No. 50229)

Literature records are Benalla (Fletcher, 1891a); Gunbower (Lucas, 1892); and Bruthen and Kerang (Copland, 1957).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Mapoon, Gulf of Carpentaria (Nos. 3516-3524, 3526)
 Lake Barrine, near Cairns (No. 11354)
 Herbert River (Nos. 6651-6654)
 Townsville (Nos. 6942, 6943)

Eidsvold (Nos. 2928, 5348, 5925-5928, 5983)
 Brisbane (Nos. 4381, 5864)
 *Cape York (No. 5011)

The American Museum of Natural History has specimens from:

Cairns (No. 63825)
 Bina Burra, Beechmont (Nos. 63819-63824)
 *Queensland (No. 23975)

The British Museum (Natural History) has specimens from:

Lower Edward River, Cape York (No. 1930.10.11.-3)
 Cooktown (No. 98.10.19.20)
 Inkerman, Burdekin River (Nos. 1908.2.25.41-1908.2.25.43)
 Mackay (Nos. 84.7.4.3, 84.7.4.4)
 Rockhampton (Nos. 76.3.4.54, 67.5.13.33)
 *Northeast Australia (No. 44.6.13.40)

Other localities for which there are literature records are: Burnett River district (Boettger, 1894); Innisfail (Mertens, 1958a); Coomoolaroo, Talafa, Kolonga Creek, Noondoo, and Callandoon (Slevin, 1955); and Tambourine Mountain, St. George, Condamine Downs, Whetstone, Jandowae, and Calliope (Copland, 1957).

NORTHERN TERRITORY RECORDS

The Australian Museum has specimens from:

Cape Arnhem (Nos. 13587, 13588)
 Groote Eylandt (Nos. 9725-9727, 11020)
 Yam Creek (old series No. 4913)

The British Museum (Natural History) has a specimen from:

Port Essington (No. 44.5.13.36)

Another locality, mentioned in the literature, is Oenpelli (Mitchell, 1955).

SOUTH AUSTRALIA RECORDS

There are literature records for the *Murray Valley (Thomas, 1958), lower reaches of the Murray at Tailem Bend (Mitchell, 1955), and Murray Bridge (Copland, 1957).

WESTERN AUSTRALIA RECORDS

The British Museum (Natural History) has a specimen from:

Albany (No. 85.9.2.24)

It should be noted that Main (1954a) does not include *Hyla peroni* in his list of the amphibians of southwest Australia. This Albany

record must be accepted with considerable reserve.

There are literature records for *Jedda (= Jeeda?) and Noonkambah in the Kimberley district (Andersson, 1913a) and King's Sound (Fletcher, 1898).

TASMANIA

Amphibians with the specific name *peroni* have a difficult time with their status in Tasmania. The case of *Limnodynastes peroni* is discussed above. As we shall see, there is also a problem with *Hyla peroni*.

Günther (1858) lists an adult of *Hyla peroni* from Van Diemen's Land that was presented to the British Museum (Natural History) by Sir A. Smith. Boulenger (1882) mentions the same specimen as being in the British Museum collections.

Krefft (1865), Fletcher (1898), English (1910), Lord and Scott (1924), Loveridge (1934), and Scott (1942) all refer to the British Museum specimen and express varying degrees of doubt regarding the accuracy of the locality.

Scott (1942) thinks that the "Tasmanian" specimen may, in fact, be his own *Hyla burrowsi*.

The British Museum (Natural History) has the specimen, which is numbered 1858.11.25.52. The original register gives no locality, the species register gives "Tasmania," and the label on the bottle gives "Queensland." In each case Sir A. Smith is indicated as the source of the specimen. There is a label on the specimen, but this has no writing visible to the eye. When account is taken of this confusion, it is clear that there is no basis for believing that *Hyla peroni* occurs in Tasmania.

This notorious specimen is *Hyla peroni* and not *Hyla burrowsi* as Scott (1942) suggested.

LITERATURE

Hyla peroni was first collected on the voyage of Péron and Lesueur and described by Duméril and Bibron (1841). Tschudi ("1839" [1838]), however, referred to an unpublished description of it by Bibron, and, because his work was published first, he becomes the "describer." He used the name *Dendrohyas peronii*. The type is in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)].

The type locality is Australia ("Nov. Holl.").

There is only one major synonym. *Hyla rothii* was described by de Vis (1884a) on the basis of four specimens from Mackay. Boulenger (1885) examined the types and found them to be *Hyla peroni*.

General descriptions of *Hyla peroni* are given by Günther (1858 and 1863b, with two figures in color), Keferstein (1868a, with a figure of the adult and roof of the mouth), Steindachner ("1869" [1867]), Boulenger (1882), Lucas and Le Souëf (1909, with a photograph of the adult), Richard Deckert (1915, as *Hyla perronii*, with two illustrations in color of an adult), Nieden (1923, with an illustration of the hand), Slevin (1955, with a photograph of a preserved adult), Copland (1957), Moore (1957a, with a photograph of an adult), and Mertens (1958a).

The habits are described by Krefft (1863), Fletcher (1889), and Harrison (1922). Johnston (1912) records the presence of nematode parasites.

The following papers consist largely of data on geographic distribution: Günther (1867), Fletcher (1890, 1891a, 1892, 1894b, 1898), Boettger (1894), Lucas (1892), Roth (1908), Andersson (1913a, 1916), Loveridge (1935), and Mitchell (1955).

Minor mention is made by Gray (1841a), Duméril (1853), Duméril and Bibron (1854), Krefft (1862, 1865, 1867, 1870), Fitzinger (1861, as *Dendrohyas peroni*), Anonymous (1883), Spencer (1892), Aflalo (1896), Lucas (1897), Fry (1912, 1914), Lord and Scott (1924), Chisholm (1925), Loveridge (1934), Smith (1929), Kinghorn (1931, 1944), and Thomas (1958).

Hyla citropa (Tschudi)

THE BLUE MOUNTAINS TREE FROG

Plate 43, figure 3; text figures 51, 52

DIAGNOSIS

A combination of the following characteristics separates this species from all others in the eastern New South Wales area: discs moderately well developed; posterior edge of vomerine teeth posterior to the choanae; fingers not webbed; head broad; canthus a sharp ridge that continues as a supratympanic fold.

This species is superficially similar to *Hyla lesueuri*. The two can be distinguished as

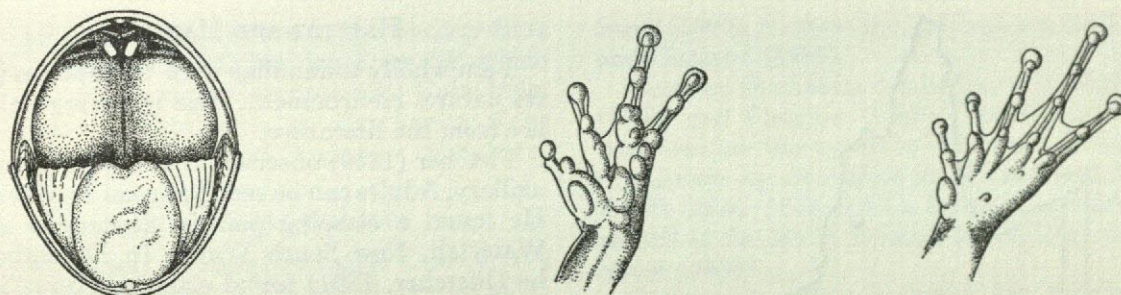


FIG. 51. *Hyla citropa*. Open mouth, hand, and foot. A.M.N.H. No. 63843. Waterfall, National Park, New South Wales.

follows: in *Hyla citropa* the posterior surface of the thigh is pale, whereas it is black, with light spots, in *Hyla lesueuri*.

DESCRIPTION

I did not observe adults of this species in the field, and all of my observations are based on preserved specimens and a single living juvenile.

The dorsal surface varies from blue-gray (green in life) to brown. There is no obvious pattern, although in some specimens the back has a few small, dark spots. The dorsal surface is smooth.

The side of the head is strikingly patterned. There is a brown stripe below the canthus that continues across the top of the tympanum and along the side to a point about halfway between the arm and the leg. Below this brown stripe there is an area of blue (probably green in life) that occupies most of the loreal region, continues beneath the eye and tympanum, and ends at the arms. Below this there is an irregular white line or band of tiny white spots that extends along the upper jaw posteriorly to the arm.

The area behind the tympanum forms a fleshy fold, which is usually enlarged owing to the presence of larvae of the fly *Batrachomyia*.

The "concealed surfaces" (armpit, groin, and the anterior and posterior surfaces of the thigh) are a brilliant reddish orange.

In both the male and the female there is a bluish (probably greenish in life) tinge to the throat. The rest of the under parts is pale. The ventral skin is granular.

This is a tree frog of medium size. The largest individual that I have seen has a body length of 60 mm. (Australian Museum No. 7560). The body proportion ratios of 12

adults in the Australian Museum and in the American Museum of Natural History, which vary in body length from 42.3 to 59.5 mm., are as follows: tibia length/body length, 0.53 ± 0.01 (0.51–0.57); head length/body length, 0.34 ± 0.00 (0.31–0.36); head width/head length, 1.12 ± 0.01 (1.08–1.19). Measurements made on the type (Muséum National d'Histoire Naturelle, Paris, No. 4854) are as follows: body length, 51.8 mm.; tibia length, 27.9 mm.; head length, 18.2 mm.; head width, 20.0 mm.

The tympanic membrane is prominent.

The fingers are without webs, and the discs are of moderate size (fig. 51). The sequence of finger lengths is $3 > 4 > 2 > 1$. The fourth finger is nearly as long as the third. Breeding males have a nuptial pad on the thumb.

The toes have moderate webs; generally the disc and two phalanges of the fourth toe are free (fig. 51). There are a small inner metatarsal tubercle and a tiny median one.

The tongue, as in most Australian hylas, is broad and nicked posteriorly. The vomerine teeth project posteriorly well behind the choanae (fig. 51).

There are descriptions in the literature of its coloration. Krefft (1870) writes: "The colour varies; sometimes it is purple-grey with a wash of green on the back; at other times slate-grey or almost green; and young specimens taken during winter from under stones appear quite white. The inner side of the legs is pink." Kinghorn (1932) described a male and a female from Stanwell Park Creek on the south coast of New South Wales as follows: "eye golden, flecked with brown; dorsal surface light foliage green becoming paler on the sides. From the nostril along the canthus rostralis was a thin golden line, ter-

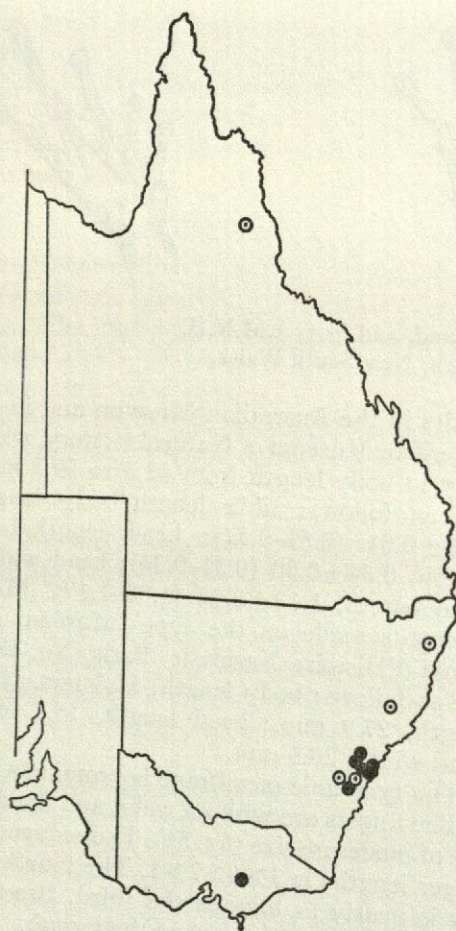


FIG. 52. *Hyla citropa*. Geographic distribution.

minating on the anterior part of the upper eyelid. From the posterior to the eyelid the golden line was thicker and bordered with brown, extending over the shoulder to the side where it broke up into fine golden flecks, giving the appearance of having been splashed with gold paint. These flecks extended to the groin, a few being on the thigh, but they gradually ceased to exist as the ventral surface was reached. The under sides of the lower jaw were pale green, merging into greenish white on the throat. The belly was pale salmon and the anal area a rich brown. The groin and hinder sides of the thigh were rich reddish tan, bordered above by maroon. The armpits were yellowish tan bordered above by a darker shade. The female was coloured the same, but the green was a much darker shade, without any trace of olive or brown."

HABITAT AND HABITS

I am wholly unfamiliar with this species in its natural environment. The following data are from the literature.

Fletcher (1889) observed that clasping was axillary. Adults can be seen "abroad by day." He found a clasping pair in September at Waterfall, New South Wales. In December he (Fletcher, 1891) found clasping pairs "in a little pool overshadowed by a fallen tree-trunk in a gully." This was near Springwood in the Blue Mountains of New South Wales.

Long ago Krefft (1863) noticed the presence of fly larvae (*Batrachomyia*) under the skin posterior to the tympanic membrane.

Krefft (1870) refers to *Hyla citropa* as an inhabitant of high trees in the non-breeding season, which perhaps accounts in part for its rarity.

GEOGRAPHIC DISTRIBUTION

Hyla citropa occurs in the mountains and coastal areas of eastern New South Wales and in the mountains of Victoria (fig. 52). It has been recorded, on questionable evidence, from northern Queensland. The type locality is Port Jackson (= Sydney).

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Hazelbrook, Blue Mountains (No. 7110)
Katoomba (No. 5188)
Pennant Hills, Sydney (No. 8459)
Lindfield (No. 4326)
Ryde (old collection No. 7111)
Manly (No. 7563)
Middle Harbor (Nos. 7112-7114)
Mulgoa (old collection No. 7117)
Bundanoon (No. 4161)

The American Museum of Natural History has specimens from:

Waterfall (Nos. 63843, 63844; formerly Nos. 7558, 7559 of the Australian Museum)
National Park (No. 64028, a juvenile)

The British Museum (Natural History) has specimens from:

Mt. Wilson (No. 87.7.16.4)
Sydney (No. 61.11.18.27)
*Erumanga? (No. 60.6.19.36)
*New South Wales (Nos. 63.6.16.88, 63.6.16.99)
*Australia (Nos. 63.6.16.80-63.6.16.82)

All these localities are in the Sydney-Blue Mountains area. Other localities for which there are literature records are: Colo Vale, Grafton, Tubrabucca on Barrington Tops (Copland, 1957), and Hampton (Kinghorn, 1932).

QUEENSLAND RECORDS

Andersson (1916) gives Cedar Creek on the Atherton-Herberton Tableland as a locality. This is based on a juvenile individual collected by Mjöberg's expedition. As can be seen from the map (fig. 52), this locality is remote from other areas where this species is known. Copland (1957) has suggested that the identification may be in error, as the specimen was probably a recently metamorphosed individual. Obviously it must be questioned.

VICTORIA RECORDS

The Australian Museum has specimens from:

Aberfeldy (Nos. 7560-7562)

Kinghorn (1932) was puzzled by these specimens, because they came from a locality far from the familiar range of this species. He suggested that they might be *Hyla dentata*. I have examined these specimens, and they seemed to be perfectly typical *Hyla citropa*. Copland (1957) examined them later and agrees. Of course, it is not possible to be as sure of the locality as of the specimens. We must remember, however, that the amphibian fauna of southern New South Wales and nearly all of Victoria is very poorly known.

LITERATURE

The first reference to this species is by Tschudi ("1839" [1838], using the name *Dendrohyas citropa*) who referred to a description of *Hyla citropa* in a manuscript by Péron and Lesueur. The first description is by Duméril and Bibron (1841), whose material was from Port Jackson. The type is in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)]. Fitzinger (1943) referred to the species as *Hyla (Dryopsophus) citropa*. All other citations of this species are as *Hyla citropus* or *Hyla citropa*.

General descriptions are given by Keferstein (1868a, with figures of the adult and palate), Boulenger (1882), Lucas and Le

Souëf (1909), Nieden (1923), Kinghorn (1932), and Copland (1957).

Notes on the habits can be found in Krefft (1863) and Fletcher (1889). The trematode parasites are discussed by Johnston (1912). Parasitism by *Batrachomyia* is discussed by Krefft (1863; 1864, with a figure of the larva as well as the cavity it forms in the frog) and Skuse (1889).

Geographic data are given by Fletcher (1890, 1891a), Andersson (1916), and Loveridge (1935).

There are brief mentions of this species in Gray (1841a), Günther (1858, 1868a), Krefft (1865, 1867), Anonymous (1883), Beottger (1892), Fletcher (1894b), Aflalo (1896), Smith (1929), Harrison (1922), and Guibé (1950?).

Hyla dentata Keferstein

KEFERSTEIN'S TREE FROG

Plate 43, figure 4; text figures 53, 54

DIAGNOSIS

A combination of the following features separates this species from all others in eastern New South Wales: large discs on the fingers and toes; posterior edge of vomerine teeth behind the level of the choanae; and a broad light band extending from the eye, across the shoulder, and along each side to the groin, delimiting a characteristic dorsal patch (pl. 43, fig. 4).

Hyla dentata may be confused with *Hyla ewingi* and *Hyla jervisiensis* on one hand and *Hyla rubella* on the other. *Hyla dentata*, *Hyla ewingi*, and *Hyla jervisiensis* all have a dark patch on the back. In *Hyla dentata* this patch extends to the tip of the snout, but in the other two it ends at the level of the eyes. In addition, the lateral edges of this patch are crooked in *Hyla dentata* but nearly straight in the other two species. Finally, the discs are much larger in *Hyla dentata* than in either *Hyla ewingi* or *Hyla jervisiensis*.

Hyla dentata differs from *Hyla rubella* (pl. 44, fig. 1), which in New South Wales is an inland species, by having a slanting loreal region, which is nearly vertical in *Hyla rubella*, and by having two light lateral bands, which are absent in *Hyla rubella*.

DESCRIPTION

I did not collect *Hyla dentata*, and this description is based on preserved specimens.

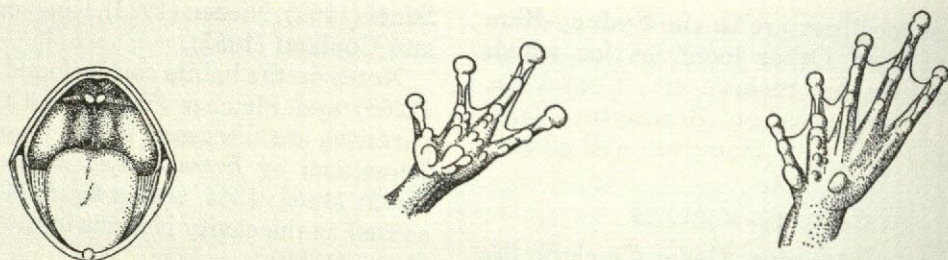


FIG. 53. *Hyla dentata*. Open mouth, hand, and foot. A.M.N.H. No. 63855. Bellbrook, New South Wales.

The characteristic pattern on the dorsal surface is shown well in plate 43, figure 4. A brown patch covers most of the dorsal surface. This patch is constricted at the level of the arms and in the middle of the back to produce, as Copland (1957) has expressed it, a "trilobed median band." Lateral to this a pale and irregular band begins at the eye and extends above the tympanum and along the sides to the groin. According to Copland it is cream-colored in living frogs. Below it an irregular brown band begins at the eye and extends through the tympanum and along the side of the body to the arm or somewhat more posteriorly. The throat of breeding males is brownish.

The skin is smooth on the dorsal surface and granular on the abdomen. The external vocal sac under the throat of the male is huge.

This is a species of medium size, with short legs and a broad head. The largest individual that I have seen is a female 46.4 mm. in body length (No. 64.10.27.29 in the British Museum; probably the specimen measured as 48 mm. by Boulenger, 1882). The body proportion ratios of 10 individuals in the Australian Museum, which vary in length from 30.6 to 42.5 mm., are: tibia length/body length, 0.44 ± 0.01 (0.41–0.48); head length/body length, 0.28 ± 0.01 (0.26–0.31); head width/head length, 1.11 ± 0.01 (1.03–1.14).

The tympanic membrane is well developed.

The fingers are very slightly webbed (fig. 53). The sequence of finger lengths is $3 > 4 > 2 > 1$. The male has a nuptial pad on the thumb.

The toes have a moderate web, the disc and about one and a half phalanges of the fourth toe being free (fig. 53). There is a small inner metatarsal tubercle.

The tongue is broad and nicked posteriorly (fig. 53). The posterior edge of the vomerine teeth, and usually the anterior edge as well, is behind the level of the posterior edge of the choanae.

HABITS

The following observations are all from the descriptions of others.

Fletcher (1889), in his general paper, wrote: "a rare frog . . . I know nothing of the habits of this species." Again (1892) he speaks of it as being "largely terrestrial."

The paper of Harrison (1922) contains essentially all our knowledge of the natural history of *Hyla dentata*. The call is a "long drawn-out, single note, 'cree-ee-ee-ee-ee,' which is tremulous at close quarters, and almost amounts to a scream." He observed breeding the first week in January. The adult "sits round the edge of the water, among grasses, and its spawn, which resembles very closely that of *H. phyllochroa*, is deposited in an irregular mass tangled about the grass in extremely shallow water. The tadpole at hatching is very bright yellow, and the much branched external gills are rapidly developed at, or immediately after hatching."

GEOGRAPHIC DISTRIBUTION

Hyla dentata is known only from the mountains and coastal plain of eastern New South Wales from the Queensland border to Jervis Bay (fig. 54). The type locality is New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Evans Head (No. 12293)
Gurravembi, Nambucca River (Nos. 6326, 6327)
Nambucca River (No. 5896)

Raymond Terrace (No. 9280)
 Tuggerah Lakes (No. 4907)
 Wyong (Nos. 10507, 10508, 11069)
 Brush Creek, Wyong (No. 13073)
 Somersby, via [near] Gosford (No. 8294)
 Smithfield, near Sydney (No. 5252)
 Parramatta (Nos. 3952, 5102)
 Campbelltown (No. 778)
 Woonona, near Bulli (Nos. 4655-4657, 4659)
 Fitzroy Falls (No. 8457)

There is also a specimen in the old collection (No. 2843, a purchase) from Pallamallawa. This locality is between Warialda and Moree on the Gwydir River. This record is the only one for the area west of the mountains. It is open to question and has not been entered on the distribution map.

The American Museum of Natural History has specimens from:

Lismore, Richmond River (No. 13348)
 10 miles southeast of Bellbrook (No. 63855)

There is some doubt of the accuracy of the identification of the Lismore specimen. It was received from the Australian Museum (No. 5080) as *Hyla rubella*. It is badly bleached, so the characteristic dorsal pattern of *Hyla dentata* is not present. On the basis of less satisfactory characteristics it resembles *Hyla dentata* more than *Hyla rubella*.

The British Museum (Natural History) has specimens from:

Gosford (No. 86.7.3.29)
 Sydney (Nos. 64.10.27.29, 64.10.27.30, 76.3.4.46, 76.3.4.47, 76.3.4.50, 76.3.4.51, 76.3.4.57)
 Illawarra (Nos. 88.7.3.28, 90.7.28.6)
 Huskisson, Jervis Bay (No. 1935.4.2.2)

Other localities for which there are only literature records are: Blue Mountains (Fletcher, 1892), Ulmarra to Chatsworth on the lower Clarence (Fletcher, 1894b), and Tooloom Falls, near Urbenville (Copland, 1957).

COMMENTS

Hyla dentata and *Hyla rubella* resemble each other rather closely, and the relation of their geographic ranges is interesting. As is discussed above, *Hyla dentata* (fig. 54) is restricted to a narrow belt along the east coast of New South Wales (with the possible exception of the Australian Museum specimen from Pallamallawa).

Hyla rubella ranges from the northwest

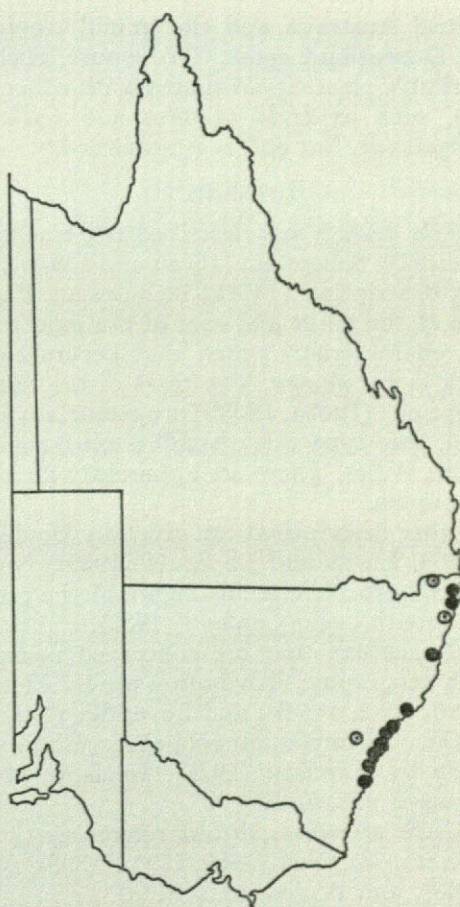


FIG. 54. *Hyla dentata*. Geographic distribution.

coast of Australia across the northern half of the continent to the coast of Queensland. In New South Wales it is absent from the coast (with the possible exception of the Lismore specimen in the American Museum of Natural History referred to above, which is probably *Hyla dentata*). It appears that the ranges of *Hyla dentata* and *Hyla rubella* are contiguous, but I know of no locality where both occur.

On the east coast of Australia, according to our present knowledge, *Hyla dentata* extends from Jervis Bay to the Queensland border, and *Hyla rubella* extends from the Queensland border to Cape York. This seemingly exact replacement is a fascinating problem for further study.

One might also pause to marvel that *Hyla rubella* is common in both the deserts of

central Australia and the humid tropics of the Queensland coast. To be sure, such remarkable plasticity is shared with other species, such as *Hyla caerulea* and *Cyclorana alboguttatus*, but still it is noteworthy.

LITERATURE

Hyla dentata was described twice as a new species by Keferstein (1868a and 1868b). The first description (1868a) includes an illustration of the adult and roof of the mouth, but the characteristic patch that occurs on the back is not shown. The texts of the two descriptions (1868a, 1868b) are essentially identical. The type was a small adult from New South Wales. There are apparently no major synonyms.

Other descriptions are given by Boulenger (1882), Lucas and Le Souëf (1909), Nieden (1923, with Keferstein's figure of the roof of the mouth), and Copland (1957).

Discussions that are concerned primarily with geographic distribution are by Fletcher (1890, 1892, 1894b) and Loveridge (1935).

The only important field observations were made by Harrison (1922). Johnston (1912) discusses parasites.

There are unimportant references to this species in Fletcher (1889, 1891a, 1898), Afalo (1896), and Andersson (1913a).

THE *HYLA EWINGI* COMPLEX

I introduce the discussion of the species in this complex with an apology rather than end with a synthesis. With respect to the status of most of the species that are discussed in the present report, I am reasonably confident that it is understood. With respect to the *ewingi* complex, I am equally confident that my understanding is incomplete. I have, however, been able to examine many type specimens, and some problems that were perplexing for decades have been solved.

In the Sydney region I encountered two species. When one has an opportunity to study them in the field, there is no real problem in recognizing them, as they differ greatly in size, habitat, call, and, to a lesser extent, color pattern. One is *Hyla ewingi*, which is abundant and widespread, and the other is *Hyla jervisiensis*, which in the Sydney region I found only in National Park. The conclusion that there are only two species was

reached, but it is necessary to reveal the steps leading to it, as there is a great deal of confusion regarding the status of the forms involved.

There are 10, or possibly 11, names that have been applied to the *ewingi*-like frogs of eastern New South Wales, namely, *Hyla ewingi*, *Hyla kreffti*, *Hyla ewingi calliscelis*, *Hyla verreauxi*, *Hyla ewingi verreauxi*, *Hyla ewingi orientalis*, *Hyla ewingi alpina*, *Hyla ewingi loveridgei*, *Hyla jervisiensis*, *Hyla parvidens*, and possibly *Hyla schuettei*. Various authors have used these names in different ways, and the confusion is increased when one considers not only eastern New South Wales but the entire geographic area occupied by members of the *ewingi* complex.

The British Museum (Natural History) has a specimen of *Hyla ewingi* (No. 52.12.11.3, recatalogued as No. 1947.2.22.75), which is labeled "One of the types. Tasmania. V.D. Land. Zool. Socy." This is conspecific with the Sydney frog that I am calling *Hyla ewingi*. The Museum National d'Histoire Naturelle in Paris also has a specimen (No. 4851) of *Hyla ewingi* that is listed as the type. The label reads: "*Hyla ewingi* D. et B. Dum. Bib. Hist. Rept. T 8 p. 579. Van Diemen: Soc. Zool. Lond." This also is conspecific with the Sydney frogs that I am calling *Hyla ewingi*.

The species that I found at National Park I first thought to be *Hyla kreffti*, because when I compared my specimens with the type of *Hyla kreffti* in the British Museum (Natural History), they were the same. Later, however, I examined the type of *Hyla jervisiensis* in the Museum National d'Histoire Naturelle and found it to be the same as my National Park specimens as well as the type of *Hyla kreffti*. As the earlier name is *Hyla jervisiensis*, *Hyla kreffti* must become a synonym.

Therefore, so far as my experience is concerned, two species of the *ewingi* complex are in the Sydney region. To one the name *Hyla ewingi* is appropriate and should be used, unless it can be shown that the individuals from New South Wales that are placed in this species at the present time are specifically different from the individuals in Tasmania (the type locality). The other species is *Hyla jervisiensis*. When one has mature and living individuals of the two species or can observe

them in nature, there is no problem in distinguishing them. On the other hand, it is difficult to be sure of immature, old, faded, and poorly preserved specimens.

Because each person who has studied the *ewingi* complex has treated it differently, an effort must be made to understand how the various names were used. As a matter of convenience, I start with Boulenger, but the confusion is much older.

Boulenger (1882) had specimens of *Hyla ewingi* from Tasmania, Victoria, and Western Australia. These are in the British Museum, and they agree with my conception of this species. The Western Australian individuals have purplish black spots on the groin and hind side of the thigh. These he separated as var. A and believed to be the same as *Hyla calliscelis*, which was described by Peters (1875, with Adelaide as the type locality).

Boulenger also listed *Hyla kreffti* from Sydney, Randwick, Port Denison, New Holland, and ?Tasmania. The Sydney (including the type), Randwick, and one of two New Holland specimens are the same as my National Park species, which is *Hyla kreffti* of many authors but is really *Hyla jervisiensis*. The Port Denison, the other New Holland, and the ?Tasmania specimens are, in my opinion, *Hyla ewingi*.

Boulenger did not realize that *Hyla kreffti* is the same as *Hyla jervisiensis*. He knew *Hyla jervisiensis* only from the literature, but it is clear that he did not believe it to be closely related to either *Hyla ewingi* or *Hyla kreffti*, for he writes that it is "allied to *H. coerulea*."

Nor did Boulenger have specimens of *Hyla parvidens*, which had been described by Peters (1875), with Port Phillip as the type locality. He believed, nevertheless, that *Hyla parvidens* was similar to *Hyla ewingi*.

Hyla verreauxi, which was described by Duméril (1853), was omitted from the "Catalogue" by Boulenger. The omission was an oversight (see Fletcher, 1889, p. 387), and Boulenger thought "that it is probably a variety of *H. ewingii*."

The Muséum National d'Histoire Naturelle in Paris has the specimens that formed the basis of the description of *Hyla verreauxi*. Number 4849 consists of five specimens

labeled "*Hyla verreauxii* A.D./A. Dum. Ann. Sc. Nat. 1854 p. 171/Botany Bay: J. Verreaux. T." Number 4850 consists of nine specimens. The label is the same except for the last line, which reads "Sydney: J. Verreaux. Type." Identification is difficult as the No. 4849 series is bleached, but the No. 4850 series is somewhat better. Some of the individuals are certainly *Hyla ewingi*, but others are so poorly preserved that it is impossible to be sure of their identity. *Hyla jervisiensis* may be included among these, as some of the individuals are larger than is usual for *Hyla ewingi* in the Sydney region. Probably the best course, however, is to consider *Hyla verreauxi* a synonym of *Hyla ewingi*.

Fletcher was familiar with two forms in the *ewingi* complex near Sydney. In his first major paper (1889) he refers to *Hyla ewingi* var. *calliscelis* as one of the commonest frogs of the Sydney region. *Hyla kreffti* was listed as "not very common." In 1890 he mentioned that *Hyla jervisiensis* "is not known to me." In 1892 he reported that *Hyla ewingi* from Lucknow, New South Wales, had more spots than Boulenger's (1882) var. A (*calliscelis*) and referred to it as var. B. In 1894b he reports a visit to the type locality of *Hyla jervisiensis*, namely, Jervis Bay and says "my hopes of finding that extremely rare frog *Hyla jervisiensis* were not realized, . . . the species is, I believe, still known only from the type specimen." Loveridge (1935) mentioned that "Fletcher records that he sought for *jervisiensis* at Jervis Bay but only found *kreffti*." If correct, the record would be most important, but I cannot find any evidence that Fletcher took either *Hyla kreffti* or *Hyla jervisiensis* at Jervis Bay. (Undoubtedly Fletcher followed Boulenger in believing *Hyla jervisiensis* to be very different from *Hyla kreffti*.)

In 1898 Fletcher gave his final views on the *ewingi* complex. The typical unspotted form of *Hyla ewingi* is found in Tasmania and Victoria. The spotted var. *calliscelis* occurs in Tasmania, Victoria, South Australia, and Western Australia. In New South Wales there is another spotted form for which he proposed a new varietal name, *orientalis*. He changed his opinion about *Hyla kreffti*, believing it to be an unspotted variant of

Hyla ewingi orientalis. It is of importance to note that all his specimens of *Hyla ewingi kreffti* were "from three localities all within a distance of about 60 miles from Sydney." Furthermore, Fletcher believed that *Hyla verreauxi* and *Hyla parvidens* were synonyms of *Hyla ewingi*. Thus, Fletcher finally came to believe that the *ewingi* complex consisted of a single species with four varieties.

Fry (1915) was also of the belief that a single species was involved. However, he described a fifth variety, *Hyla ewingi alpina*, from the Mt. Kosciusko area.

Loveridge's (1935) understanding of the *ewingi* complex is very different from that of the previous authors. *Hyla parvidens*, which was known only from the Port Phillip (Victoria) types, was revived for two individuals from Botany Bay, New South Wales. *Hyla kreffti* was regarded as a synonym of *Hyla jervisiensis*. Above, I give my reasons, based on an examination of the types, for believing that this is correct. However, *Hyla jervisiensis* of Loveridge seems to be quite different from *Hyla jervisiensis* as I understand it. Most of his specimens were from Tasmania, but some were from New South Wales and South Australia. I agree with Fletcher (1898) in believing that *Hyla jervisiensis* is restricted to eastern New South Wales (the type localities for *Hyla jervisiensis* and *Hyla kreffti* are Jervis Bay and Sydney, respectively). Finally Loveridge recognized *Hyla ewingi ewingi*, *Hyla ewingi verreauxi*, and *Hyla ewingi alpina*. Fletcher's (1898) *Hyla ewingi orientalis* was listed as a synonym of *Hyla ewingi verreauxi*.

I have examined the specimens that Loveridge described. The *Hyla parvidens* (Museum of Comparative Zoölogy Nos. 9585, 9586) are *Hyla ewingi*, but I doubt that they are from Botany Bay. They appear to be identical with the specimens of *Hyla ewingi* that I collected at Binna Burra, Queensland. Loveridge's specimens were secured from a dealer, and it is possible that the locality is incorrect. The specimens certainly are not the Sydney type of *Hyla ewingi*.

One of the specimens (Museum of Comparative Zoölogy No. 3603) identified by Loveridge as *Hyla jervisiensis* is the same as my *Hyla jervisiensis*. The specimen is from "Naroubra" (undoubtedly Maroubra is

meant). Most of his other specimens of *Hyla jervisiensis* are from Tasmania. I would refer nearly all of these, without hesitation, to *Hyla ewingi*, but there are a few individuals for which I can offer no sure identification. They are intermediate in many respects between the individuals of *Hyla ewingi* and those of *Hyla jervisiensis* of the Sydney area. Therefore, a final decision on the number of species in Victoria and Tasmania that belong to the *ewingi* complex must await adequate field data to supplement the information that can be obtained from preserved specimens.

Copland, in his monograph of the Australian hylas (1957), listed *Hyla parvidens*, but he remarked, "Taken all in all it is practically certain that *parvidens* should be sunk in the synonymy of *ewingii*." Six subspecies of *Hyla ewingi* were recognized, namely, *ewingi*, *calliscelis*, *alpina*, *verreauxi*, *iuxtaewingi*, and *loveridgei*. The last two were new. *Hyla kreffti* was listed as a synonym of *Hyla ewingi verreauxi*. The reasons why this is incorrect are given above. *Hyla jervisiensis* was listed from Lawson, Blackheath, Moss Vale, Leura, and Gosford in New South Wales, Launcheston in Tasmania, and Flinders Island. For the most part I agree with Copland's opinions about this species. When I studied the Australian Museum specimen in 1953, I identified these same New South Wales specimens as *Hyla kreffti*, not having seen the types of *Hyla jervisiensis* (which I later realized was the correct name). I cannot find any record that I saw the Tasmania and Flinders Island specimens, but, on the basis of my understanding of *Hyla jervisiensis*, I doubt that they are this species.

Two other names may refer to the *ewingi* complex. Long ago Kerferstein (1868a, 1868b) described *Hyla schuettei* from Sydney. Boulenger (1882) made it a synonym of *Hyla adalaidensis*. Such an action is probably correct, but, if so, the type locality is in error. If, however, the specimen really did come from Sydney, it is hard to say what it is. Ahl (1935) described as new *Hyla inguinalis* from South Australia. Copland (1957) has suggested that it is close to *Hyla jervisiensis* and *Hyla ewingi calliscelis*. It is probably *Hyla ewingi*.

It seems to me that there are valid grounds for recognizing only two species in the *ewingi*

complex: *Hyla ewingi*, a widespread species in southeastern Australia and Tasmania, and *Hyla jervisiensis*, a species restricted to a small area in eastern New South Wales. Such a solution of the problem is conservative, but it is better to consider things the same until proved different than different until they are proved to be the same. The populations should be studied in the field to obtain information on their ecology and behavior, as well as in the laboratory where hybridization studies can be conducted. Preserved specimens of these species are of limited value.

Hyla jervisiensis Duméril and Bibron

THE JERVIS BAY TREE FROG

Plate 43, figure 1; text figures 55, 56

DIAGNOSIS

A combination of the following characteristics separates *Hyla jervisiensis* from other species in eastern New South Wales: well-developed pads on fingers and toes; second finger noticeably longer than the first; back nearly covered by a brown patch (the "*ewingi* patch") which begins at the eyes and extends to the cloaca; posterior surface of thigh reddish orange. Most of these characteristics are also present in *Hyla ewingi*, the species most likely to be confused with *Hyla jervisiensis*, and table 4 shows how the two can be distinguished.

DESCRIPTION

As is the case with most living hylas, there is considerable variation in color, even in the same individual at different times. The predominant color of the dorsal surface of *Hyla jervisiensis* may vary from a light grayish brown to dark brown mottled with black. There is, however, always a darker central patch that begins at the level of the middle of the eyes and extends to the cloaca. The patch narrows somewhat at the level of the arms but widens again posteriorly. There may be an incomplete pale stripe down the midline of this patch. A narrow dark line extends from the snout to the eye below the canthus and from the eye through the tympanum to the level of the arms. The canthus forms a sharp ridge. A prominent fold extends from the eye, across the top of the tympanum to the level of the arms, and, as in the case of *Hyla citropa*, a parasite, presumably *Batrachomyia*, is frequently embedded in this fold.

The dorsal surfaces of the arms and legs are colored like the back, except the upper arm is paler. The most striking color occurs on the concealed surfaces. The armpits, the posterior half of the sides of the body, and the anterior and posterior surfaces of the thighs are orange. This color is not present in preserved specimens; these areas become pale tan after preservation.

TABLE 4
PRINCIPAL DIFFERENCES BETWEEN *Hyla jervisiensis* AND *Hyla ewingi*
(FROM THE SYDNEY REGION)

	<i>jervisiensis</i>	<i>ewingi</i>
Maximum size		
Female	61 mm.	33 mm.
Male	49 mm.	31 mm.
Tibia length/body length ratio	0.55 (range, 0.53–0.57)	0.47 (range, 0.43–0.51)
Finger discs	Noticeably wider than fingers	About same width as fingers
Part of fourth toe not webbed	Disc and 1.5 phalanges	Disc and 2 phalanges
Web between third and fourth toes	Low point at proximal end of second phalanx from tip	Low point at middle of third phalanx
Position of nostril	Nearer snout than eye	Equidistant from snout and eye
Shape of snout, viewed laterally	Dorsal side horizontal	Dorsal side sloping down at tip
Abdomen	Less granular	More granular
Light area from below eye to angle of jaws	Inconspicuous	Conspicuous
Spots on groin	Absent	Usually present
Posterior surface of thigh in life	Orange or reddish orange	Yellow or yellowish orange

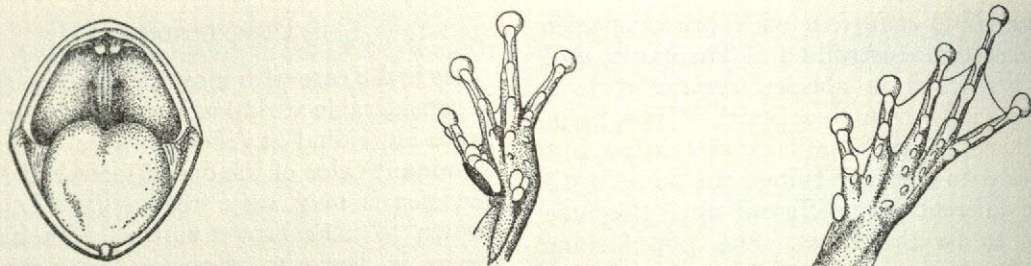


FIG. 55. *Hyla jervisiensis*. Open mouth, hand, and foot. A.M.N.H. No. 64032. Waterfall, National Park, New South Wales.

The ventral surface is white, except for a darker wash on the throat of the male.

The back is smooth and the ventral surface is finely granular. The eye is golden.

Hyla jervisiensis is a tree frog of moderate proportion. The largest female that I have seen is 61 mm. This species is, therefore, much larger than *Hyla ewingi*. The body proportion ratios of four males from Waterfall, New South Wales, in the American Museum of Natural History collection, which vary from 44.2 to 47.4 mm. in body length, are: tibia length/body length, 0.55 (0.53–0.57); head length/body length, 0.33 (0.32–0.34); head width/head length, 1.04 (1.01–1.05). Measurements in millimeters of the type of *Hyla jervisiensis* (No. 4826 in the Muséum National d'Histoire Naturelle in Paris) are: body length, 40.8; tibia length, 20.2; head length, 12.9; head width, 13.1. Similar data for the type of *Hyla krefftii* (British Museum No. 1947.2.22.78), a synonym, are: body length, 46.0; tibia length, 22.7; head length, 13.7; head width, 14.1.

The tympanic membrane is distinct. The fold above it is well developed.

The web between the fingers is vestigial (fig. 55). The discs are noticeably wider than the fingers. The sequence of finger lengths is $3 > 4 > 2 > 1$, with finger 2 much longer than finger 1. The males have a nuptial pad on the thumb.

The toes have a moderate web (fig. 55); the disc and one and a half phalanges of the fourth toe are free. The low point of the web between the third and fourth toes is at the level of the proximal end of the second phalanx (counting from the tip of the toe). There are a small inner metatarsal tubercle and a tiny central one.

The tongue is very broad and nicked pos-

teriorly (fig. 55). The vomerine teeth are between the choanae, their anterior margins being at the level of the anterior edge of the choanae.

HABITS AND HABITAT

I observed *Hyla jervisiensis* only near Waterfall, National Park, New South Wales, on March 17 and possibly at Lawler's Creek near Bodalla (pl. 32, fig. 2) on February 16. At Waterfall males were sitting on ferns, which were growing along the sides of a small stream. (Other species present at the same time were *Hyla phyllochroa*, *Hyla lesueuri*, *Crinia signifera*, and *Crinia haswelli*.) At Lawler's Creek the single individual collected was on a fern.

Fletcher (1889) found females distended with ova in July at Burrawang.

Krefft (1863) remarked at the species was often found on ferns, and Fletcher (1889) found it on cycads.

VOICE

The call is a deep, slow "wr-a-a-ck," repeated three to six times.

GEOGRAPHIC DISTRIBUTION

Hyla jervisiensis, as understood by me, is known only from a small area in eastern New South Wales (fig. 56). It occurs in the Blue Mountains and along the coast from Gosford to Bodalla. The type locality is Jervis Bay.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- Gosford (No. 10045)
- Blackheath (Nos. 5006–5008)
- Leura (No. 8461)
- Lawson, Blue Mountains (No. 2406)

Wildes Meadow, Moss Vale (No. 6509)

The American Museum has specimens from:

Near Waterfall, National Park (Nos. 64029-64032)

Lawler's Creek near Bodalla (No. 64033; identification uncertain)

The British Museum (Natural History) has specimens from:

Sydney (No. 63.6.16.87, recatalogued as No. 1947.2.22.78; type of *Hyla krefftii*)

Sydney (No. 63.5.21.1)

Randwick (No. 64.7.8.1)

*New Holland (No. 59.9.20.1)

There are literature records for *Hyla jervisiensis* that cover a much wider area. It has been recorded, for example, from Port Denison (Bowen), Queensland, to Tasmania. I seriously doubt that any of these records applies to *Hyla jervisiensis*, and none of them is shown in figure 56. Reasons for my skepticism are given in the section headed "The *Hyla ewingi* complex."

LITERATURE

Hyla jervisiensis was described by Duméril and Bibron (1841). It had been collected at Jervis Bay by Peron and Lesueur. The type is in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)].

Günther (1858) gives a short description extracted from that of Duméril and Bibron.

The subsequent taxonomic history of this species was confused by Günther's (1863a, with a poor figure of an adult) description of *Hyla krefftii*. The type locality is Sydney, and the type is in the British Museum (Natural History). It is now clear that *Hyla jervisiensis* and *Hyla krefftii* are one and the same. General works have usually listed both, but with any remarks on *Hyla jervisiensis* derived solely from the original description. It is also probable that many writers have incorrectly classified individuals of *Hyla ewingi* as *Hyla krefftii* or *Hyla jervisiensis*. Many of the references that are given below apply partially or entirely to species other than *Hyla jervisiensis*, because I question all references to *Hyla jervisiensis* from Queensland, South Australia, Victoria, and Tasmania, as well as many from New South Wales. I give here

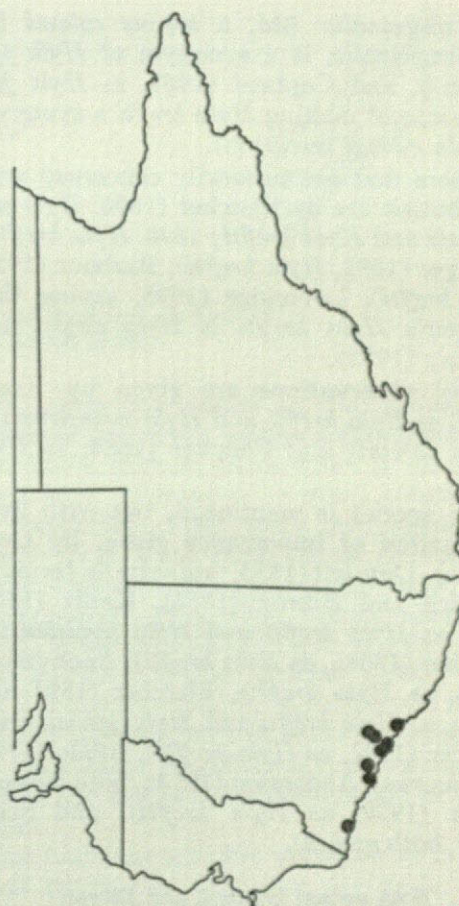


FIG. 56. *Hyla jervisiensis*. Geographic distribution.

the literature for a name, therefore, rather than for a species.

General descriptions are given by Günther (1863b, with an illustration in color of the adult and a drawing of the hand), Keferstein (1867, as *Hyla krefftii*; 1868a, also as *Hyla krefftii* and mentioning *Hyla jervisiensis*), Krefft (1870, also as *Hyla krefftii* and mentioning *Hyla jervisiensis*), Peters (1873b, as *Litoria jervisiensis*), Boulenger (1882, as *Hyla krefftii* and *Hyla jervisiensis*), Werner (1897b, as *Hyla jervisiensis*, a *lapsus calami*), Fry (1915, as *Hyla ewingi krefftii*), Nieden (1923, as *Hyla krefftii* and *Hyla jervisiensis*), Loveridge (1934 and 1935, making *Hyla krefftii* a synonym of *Hyla jervisiensis*; however, his understanding of the latter is incorrect), Condon (1941, however, probably describing *Hyla ewingi*; also suggesting that

Hyla unguinalis Ahl, a *lapsus calami* for *Hyla inguinalis*, is a synonym of *Hyla jervisiensis*, and Copland (1957, as *Hyla jervisiensis*, and making *Hyla krefftii* a synonym of *Hyla ewingi verreauxi*).

Papers that are primarily concerned with distribution are by Fletcher (1890, *Hyla jervisiensis* and *Hyla krefftii*; 1898, *Hyla krefftii*), Boettger (1892, *Hyla krefftii*), Barbour (1914, *Hyla krefftii*), Loveridge (1935, saying that Barbour's *Hyla krefftii* is *Hyla dayi*), and Mackay (1955).

Field observations are given by Krefft (1863, as *Hyla krefftii* and *Hyla jervisiensis*, a *lapsus calami*) and Fletcher (1889, as *Hyla krefftii*).

The species is mentioned, but with little information of importance given, by Gray (1841a), Duméril (1853, "rainette de Jervis"), Duméril and Bibron (1854), Krefft (1865, 1867, as *Hyla krefftii* and *Hyla jervisiensis*), Günther (1868a, as *Hyla krefftii*), Anonymous (1883, as *Hyla krefftii*), Fletcher (1892 and 1894b, as *Hyla krefftii* and *Hyla jervisiensis*), Spencer (1892, as *Hyla krefftii*), Aflalo (1896, both names), Andersson (1913a, both names), Smith (1929, as *Hyla krefftii*), and Scott (1942, both names).

Hyla ewingi Duméril and Bibron

THE BROWN TREE FROG

Plate 44, figures 2-4; text figures 57, 58

DIAGNOSIS

A combination of the following characteristics separates *Hyla ewingi* from other species in eastern New South Wales: moderately developed pads on fingers and toes; second finger noticeably longer than the first; back nearly covered by a brown patch (the "*ewingi* patch") which begins at the eyes and extends to the cloaca; and posterior surface of thigh yellowish. Most of these characteristics are also present in *Hyla jervisiensis*, the species most likely to be confused with *Hyla ewingi*, and table 4 shows how the two can be distinguished.

DESCRIPTION

Hyla ewingi is a widespread species that shows considerable geographic variation. The description that is given here is based

on individuals inhabiting the Sydney region. Geographic variation is considered below in a separate section.

The most characteristic feature in the pattern of this species is the patch on the back. As in *Hyla jervisiensis*, it begins at the level of the center of the eyes and extends to the cloaca. In living animals, at night, this patch is generally a very dark brown or black on a dark brown background. Individuals in the laboratory may have a pale gray back, with only a suggestion of the darker patch (pl. 44, fig. 3). In roughly half of the individuals collected near Sydney the patch has a light median stripe.

A narrow dark stripe below the canthus extends from the snout through the nostril to the eye. This continues as a wider stripe from the eye through the tympanum to the level of the arms.

A white line on the upper jaw begins beneath the eye and extends to the hinge of the jaws or somewhat more posteriorly. It is wider near its anterior end. The entire loreal region may be pale.

The anterior and posterior surfaces of the thigh are yellowish or yellowish orange. Nearly all individuals from the Sydney area have small or moderately large black spots or blotches in the groin.

The ventral side is white. In males the anterior half of the throat is dark.

The dorsal surface is moderately smooth, and the ventral surface is granular, noticeably so for a small species.

This is a small species, with short legs and a fairly broad head. The largest individual collected in the Sydney area was a female 33.1 mm. in body length. The largest male was 31.1 mm. The body proportion ratios of 13 males (with pigmented throats) from the eastern New South Wales area, which vary in body length from 26.4 to 31.1 mm., are: tibia length/body length, 0.47 ± 0.01 (0.43-0.51); head length/body length, 0.33 ± 0.00 (0.31-0.35); head width/head length, 1.06 ± 0.01 (1.02-1.11). Measurements in millimeters for the type of *Hyla ewingi* (No. 4851 in the Muséum National d'Histoire Naturelle in Paris) are: body length, 32.5; tibia length, 15.1; head length, 10.0; head width, 10.2. The type in the British Museum (No. 52.12.11.3, recatalogued as No. 1947.2.22.75) is so poorly

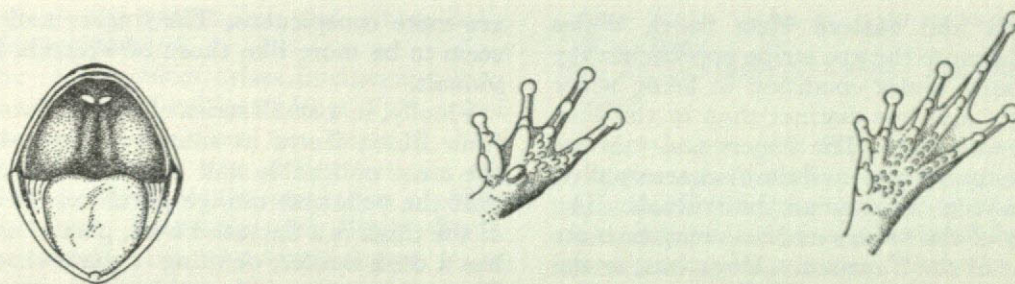


FIG. 57. *Hyla ewingi*. Open mouth, hand, and foot. A.M.N.H. No. 64065. Burradoo, New South Wales.

preserved that accurate measurements cannot be made.

The tympanic membrane is prominent.

There is a finger web that is so slight that it is usually not obvious without a magnifying lens (fig. 57). The fingers are long and delicate. The discs are poorly developed, being about the same width as the fingers themselves. The sequence of finger lengths is $3 > 4 > 2 > 1$. The breeding male has a brown nuptial pad on his thumb.

The toes are also delicate, with the discs poorly developed (fig. 57). The web is moderately developed, with the disc and two phalanges of the fourth toe free. The low point of the web between the third and fourth toes is opposite the middle of the third phalanx of the fourth toe (counting from the tip).

The tongue is moderately broad and has a posterior nick (fig. 57). The vomerine teeth are between the choanae.

GEOGRAPHIC VARIATION

Hyla ewingi, as do all widely distributed Australian amphibians, shows geographic variation. It would be remarkable if such were not the case. From the number of subspecies described, one would gather that it is unusually variable. It is not. I believe that the naming of so many subspecies is a consequence of errors made by early workers. Material was scanty, and the published descriptions were not always adequate. As a consequence, the species was described many times. *Hyla ewingi* was described from Tasmania; *Hyla calliscelis*, from Adelaide; *Hyla verreauxi*, from Sydney; and *Hyla parvidens*, from Port Phillip. (And of course *Hyla krefftii* described from Sydney and *Hyla jervisiensis*

from Jarvis Bay added to the confusion.) Whenever numerous names are available, it is probable that an extra effort is made to detect local differences, so many subspecies are recognized. That there are differences among these local populations cannot be denied. However, the variation is slight, and no prominent geographic breaks serve to delimit subspecies, which is abundantly made clear by the fact that Fletcher (1898), Fry (1915), Loveridge (1935), and Copland (1957) all had a large quantity of material available, and each came to different conclusions regarding the number and distribution of subspecies.

The major geographic variation is in the dorsal patch, the spots on the groin, the line beneath the eye, and the shape of the fingers and toes. The following descriptions are from specimens that I collected; the material in the Australian Museum was not studied in detail.

When a series of 11 specimens from the Lake St. Clair area of Tasmania (the largest is a male 33 mm. in body length) is compared with eastern New South Wales individuals, it is found that the white line from the eye to the arm is more distinct, spots are absent from the groin, the fingers and toes are shorter and broader, and the discs are better developed in the former. The webbing between the fingers is slightly better developed. The webbing between the toes is better developed, only the disc and one or one and a half phalanges being free. The low point of the web between the third and fourth toes is at the level of the proximal end of the second phalanx from the tip of the toe.

Eleven individuals were collected at Olinda, Victoria. These are intermediate between the

Tasmania and eastern New South Wales forms. In most the eye stripe approaches the New South Wales condition in being wider anteriorly and less distinct than in the Tasmanian specimens. The fingers and toes are longer and narrower, and the discs are smaller, than in the Tasmanian individuals. The webbing of the fingers and toes may be more like that of the Tasmanian frogs, but, as the difference is so slight, it is difficult to be sure. There are no prominent spots on the groin.

In many respects the population of the Mt. Kosciusko area is the most distinctive of any. This was named *Hyla ewingi alpina* by Fry (1915). There is much more green on the dorsal surface (bluish gray in alcohol), and in many of the individuals the dorsal "ewingi patch" is disrupted or absent. When present, it is divided by a broad central stripe. The juveniles shown in plate 44, figure 4, give an indication of the variability. These individuals were collected at the Chalet at an elevation of 5740 feet. Two individuals from Bett's Creek Camp (5000 feet) were of the *alpina* type, that is, without the "ewingi patch." A single individual from Saw Pit Creek, 6 miles east of Hotel Kosciusko (3900 feet) had a typical "ewingi patch." The hand and foot structure of all these is similar to that of the eastern New South Wales individuals.

Individuals from the Armidale area of New South Wales are much like those from the Sydney area. In some, the spots on the groin

are more conspicuous. The fingers and toes seem to be more like those of Victoria individuals.

Finally, in a small series of four individuals from Binna Burra in southern Queensland, the most noticeable and constant feature is that the yellowish orange patch on the rear of the thigh is a flattened oval, part of which has a dark border, defining it more sharply. The toes are more fully webbed than those of the east New South Wales individuals, only the disc and one phalanx of its fourth toe being free. The toes are not so long as in the eastern New South Wales individuals, and the discs of both the fingers and toes are better developed.

Table 5 gives data on variation in the ratio of body proportions. For two of the localities the number of individuals available for measurement is too small to be of much value. Nevertheless, the data as a whole show that the species is fairly uniform. There is a suggestion of narrower heads in the Tasmania and Queensland populations and of longer tibias in Queensland.

With the above information on geographic variation in *Hyla ewingi*, we can now digress and reconsider the difference between *Hyla jervisiensis* and *Hyla ewingi*. Table 4 gives numerous slight and some major ways that preserved individuals of the two can be separated. The critical differences are adult size and the tibia length/body length ratios, as there appears to be no overlap in these

TABLE 5
GEOGRAPHIC VARIATION IN BODY PROPORTIONS IN *Hyla ewingi*

	Num- ber	Size	Tibia Length/ Body Length		Head Length/ Body Length		Head Width/ Head Length	
			Mean	Range	Mean	Range	Mean	Range
Tasmania								
(Lake St. Clair)	10	27.5-34.0	0.47	0.44-0.54	0.33	0.31-0.35	1.02	0.96-1.08
Victoria (Olinda)	11	33.6-37.7	0.49	0.46-0.51	0.31	0.30-0.33	1.04	0.98-1.10
Kosciusko	3	29.2-31.4	0.47	0.44-0.49	0.33	0.31-0.34	1.07	1.04-1.10
Eastern New South Wales	13	26.4-31.1	0.47	0.43-0.51	0.33	0.31-0.35	1.06	1.02-1.11
Armidale (Booroolong Creek)	9	26.5-36.5	0.44	0.42-0.46	0.32	0.30-0.34	1.06	1.03-1.12
Queensland (Binna Burra)	4	29.4-31.0	0.53	0.52-0.56	0.32	0.31-0.32	1.02	1.01-1.03

factors in the geographic area where both species are present.

The real problem arises in distinguishing immature *Hyla jervisiensis* from *Hyla ewingi* of the same size. When one turns to characters other than size, difficulties are encountered. Thus, in the specimens of *Hyla ewingi* from Tasmania and Binna Burra (Queensland), and, to a lesser degree, those from Olinda (Victoria), the extent of the webbing of the toes may approach or even exceed that of *Hyla jervisiensis*. The Tasmania individuals of *Hyla ewingi* also resemble *Hyla jervisiensis* in lacking spots on the groin. The discs of the Tasmania and Binna Burra individuals are larger than those in the eastern New South Wales individuals and approach the condition in *Hyla jervisiensis*.

The tibia length/body length ratio of *Hyla ewingi* is always lower than that of *Hyla jervisiensis* except for an occasional individual from Tasmania and most individuals from Binna Burra, regions where *Hyla jervisiensis* does not occur.

When the above facts are realized, it is easy to see why the two species have been confused for so long in museum collections. It is convenient and noteworthy that the two species differ most where they are sympatric. For example, the *Hyla ewingi* that are sympatric with *Hyla jervisiensis* have smaller discs than the *Hyla ewingi* that occur elsewhere. Could this be the result of greater specialization and divergence in the sympatric areas? *Hyla jervisiensis* has well-developed discs on the fingers and toes. If we can use the extent of development of these structures as a key, certainly *Hyla ewingi* is less of a tree frog (as it has very reduced discs) in areas where *Hyla jervisiensis* occurs than it is elsewhere.

It is mentioned above that many writers have described subspecies in *Hyla ewingi*. One should refer to Copland (1957) for the latest effort. The subspecies that he recognizes and the areas where they occur are:

- Hyla ewingi ewingi*; Tasmania
- Hyla ewingi iuxtaewingi*; Southern Victoria
- Hyla ewingi verreauxi*; Victoria and lowlands of eastern New South Wales
- Hyla ewingi alpinia*; Mt. Kosciusko
- Hyla ewingi loveridgei*; highlands of Victoria and

New South Wales at lower elevations than *H. e. alpinia*

Hyla ewingi calliscelis; Victoria and South Australia

I do not consider that it is necessary to recognize subspecies in *Hyla ewingi*, but the reader must remember my bias against recognizing subspecies in frogs. It should be noted, however, that these subspecific categories for *Hyla ewingi* do not consist of uniform populations, have no sharp breaks in the pattern of variation that could serve to mark the boundaries of the subspecies, and ignore much local variation. Those persons who wish to identify their material precisely can say merely that they have *Hyla ewingi* from a particular locality.

A particular "species" category in frogs may occasionally be a fiction, but the "subspecies" is nearly always a myth.

HABITAT

This species is widely distributed in regions where there is plenty of moisture (pl. 29, fig. 1; pl. 32, fig. 2). Near Killara it was very common not only along the edges of streams but also in the woods and gardens. It occurs in lagoons along the coast. In Tasmania it is common along the edge of Lake St. Clair. In the Armidale region of New South Wales it is common along the edges of streams and lagoons (pl. 28, figs. 1, 2; pl. 30, fig. 2). At Binna Burra it occurs in the rain forest (pl. 32, fig. 1). Its most spectacular habitat is the alpine lakes and meadows of Mt. Kosciusko (pl. 31, fig. 2). Here on February 22, 1953, adults were calling in ponds formed at the edge of melting snow (7100 feet).

VOICE

The call is a merry, whirring, rapid "reed-reed-reed," each "reed" repeated six to 14 times. In some individuals the call rises and then falls. In others it seems to go slightly down the scale from beginning to end. Individuals from Tasmania, Victoria, and southern Queensland may have slightly different calls; at least they sounded so to my ear which, however, is not very good at recognizing slight differences in sounds.

To Harrison (1922) the call is a "high, hurried, piping, 'cree-cree-cree-cree-cree-cree.'"

BREEDING HABITS

At Killara breeding begins in the winter. The yellowish embryos were first collected August 3, 1952. These were raised to metamorphosis, which took nearly three months in the laboratory, in order that their identity could be checked. Tadpoles 45 mm. in total length were received from Locksley, New South Wales, on October 7, 1952. These transformed after they were in the laboratory for a month. Tadpoles about to transform were collected February 22, 1953, in Lake Albina on Mt. Kosciusko and were raised to make certain of their identification. Transforming young were observed at Uralla Lagoon and Thomas' Lagoon near Armidale, New South Wales, on November 16 and at Binna Burra, Queensland, December 16, 1952.

At Killara *Hyla ewingi* was calling when I first began field work at the end of July in 1952 and was still calling when I ceased it in late April in 1953. On cool nights, when even *Crimia signifera* was silent, it could be heard.

Both Fletcher and Harrison observed breeding. Fletcher (1889) reported that calling, and probably breeding, occur throughout the year. A clasping pair was observed June 16. The body length of the recently transformed juvenile is 12 mm. Harrison (1922) observed "spawn every month of the year. It is attached in a cylindrical mass numbering upwards of a hundred eggs to grass stalks and similar submerged objects. Each egg is surrounded by a relatively large jelly sphere, the whole being embedded in a common matrix. . . . The eggs have the pigmented pole a light brownish yellow, and the vegetable pole light yellow. They measure 1.2 mm. in diameter, and the surrounding jelly sphere 3-4 mm. . . . The tadpoles metamorphose in the field in summer weather in seven to eight weeks."

Marriner (1907) gives an account of the species in New Zealand, where it was introduced in about 1875.

EMBRYONIC DEVELOPMENT

The early stages of development of *Hyla ewingi* were not observed, but one group of larvae was collected at Killara, New South Wales. In addition, I was given two groups of tadpoles from Locksley, New South Wales.

In each case the embryos were raised to metamorphosis to establish their identity.

The youngest embryos seen were in stage 20. At this stage they were yellow. The gills were vestigial, only a single filament being present. This branched once before being overgrown by the operculum.

The tadpole appears light yellowish to the eye. The maximum size reached is 45 mm. There are five rows of teeth, two in front of the mouth and three behind. The row immediately in front of the mouth and the row immediately behind are interrupted. The anus opens to the right side of the tail fin, and the spiracle is on the left side of the body.

In the laboratory it took nearly three months before metamorphosis began. The body lengths of 11 individuals that had just completed metamorphosis varied from 14.3 to 17.0 mm.

GEOGRAPHIC DISTRIBUTION

Hyla ewingi occurs along the Queensland coast south of Cooktown, the coast and mountains and occasionally farther west in New South Wales, and in Victoria, Tasmania, and the southeast portion of South Australia (fig. 58). There is a doubtful record of its occurrence in Western Australia. The type locality is Tasmania.

It was introduced in New Zealand in about 1875 (Marriner, 1907).

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Jaffa, Ashford Downs (No. 9410)
Inverell (No. 8398)
Armidale (No. 5253, old collection)
Brooklane, E. Dorrigo (No. 9947)
Gurravambi, Nambucca River (No. 6325)
Tamworth-Walcha road (No. 10771)
Port Macquarie (No. 7080)
Barrington Tops (Nos. 13089, 13090)
Pol Blue, Barrington Tops (No. 13310)
Lucknow, Orange (Nos. 7503-7505, 8407)
Palmdale, Wyong (No. 12080)
Wimburndale Creek (No. 4819)
Oberon (No. 11549)
Fish River, Tarana (No. 3124)
Blackheath (No. 8493)
Blue Mountains (No. 4223)
Wentworth Falls (No. 8397)
Bowenfels South, Cox River (Nos. 13389-13391)
*Cox River (No. 10809)

Kurrajong Heights (Nos. 8404, 8405)
 Lindfield (No. 4817)
 Kingswood (No. 1941)
 Sydney (Nos. 7094, 7095, old collection)
 Parramatta (No. 5103)
 Smithfield (No. 2834, and others in the old collection)
 Stanmore (No. 8413)
 Mulgoa (No. 7093, old collection)
 Maroubra (No. 4208)
 Avoca (No. 8504)
 Mossvale (Nos. 446, 448, 5254)
 Burrawang (Nos. 7589, 7590)
 Bundanoon (No. 4369)
 Koonadan, Leeton (Nos. 9485-9487)
 Gerringong (No. 6130)
 Yass (No. 8417)
 Bungendore (No. 8341)
 Tumut (Nos. 9646, 9647)
 Talbingo (No. 12087)
 Mt. Kosciusko (No. 4644, type of *alpina*; Nos. 581-584, 4645, 4646, 5055, 5056, 5058, 5059, 5422-5425, cotypes of *alpina*; Nos. 5255, 5256, 10954)
 Pretty Point, Mt. Kosciusko (Nos. 7433-7438)
 Daner's Gap, Mt. Kosciusko (Nos. 10922, 13773)
 Etheridge Range, Mt. Kosciusko (Nos. 10972, 13775)
 Berridale (Nos. 4639, 4641, 5234)
 *Freebodies Hut, Ingeegoodbee River (No. 13021)

The American Museum of Natural History has specimens from:

Ben Lomond (Nos. 64055-64058)
 Black Mt. Lagoon (No. 64059)
 Ebor (Nos. 19951-20061, a poorly preserved series; No. 64060)
 Booroolong Creek, 20 miles north west of Armidale (Nos. 64046-64054)
 Capertee (Nos. 64071, 64072)
 Megalong Valley, Katoomba (No. 13349)
 Glenbrook (Nos. 64068, 64069)
 Smithfield (No. 13350)
 Kuringai Chase (Nos. 64073, 64074)
 Killara (Nos. 64061-64064)
 East Lakes, Sydney (No. 64070)
 Gerroa (Nos. 64034, 64035)
 Burradoo (Nos. 64065-64067)
 Lawler's Creek, near Bodalla (No. 64036)
 Lake Albina, Mt. Kosciusko (Nos. 64040, 64043)
 Chalet, Mt. Kosciusko (Nos. 64038, 64039)
 Betts Creek Camp, Mt. Kosciusko (Nos. 64044, 64045)
 Hotel, Mt. Kosciusko (No. 64042)
 Saw Pit Creek, Mt. Kosciusko (No. 64041)
 Eden (No. 64037)
 *New South Wales (No. 15002)

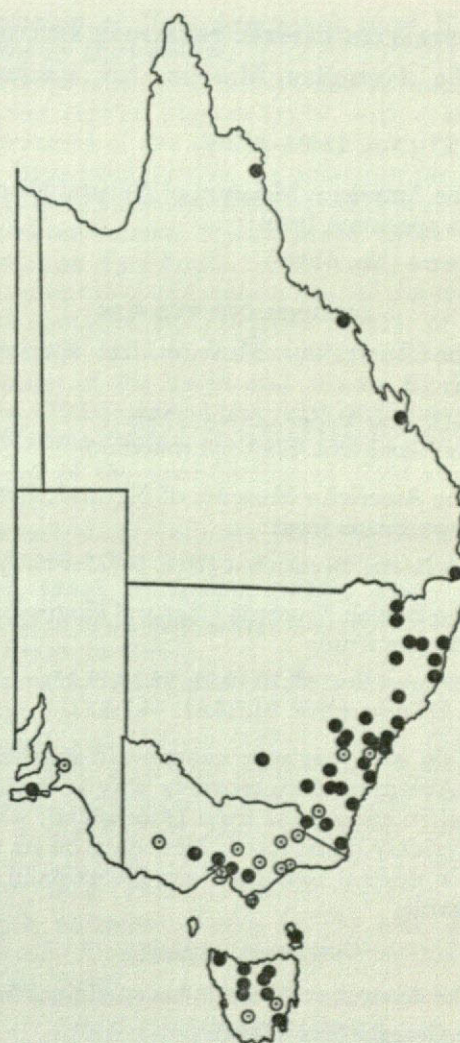


FIG. 58. *Hyla ewingi*. Geographic distribution.

The British Museum (Natural History) has specimens from:

Ebor (Nos. 1924.2.27.7-1924.2.27.10)
 Luchnow (Nos. 92.9.16.8, 92.9.16.9)
 Sydney (No. 87.7.16.8)
 Burrawang (Nos. 88.7.3.23, 88.7.3.24)
 *Australia (Nos. R.R. 1936.12.3.196-1936.12.3.198)
 *New Holland (No. 58.11.22.2)

Localities for which I have literature records only are Ulong (Slevin, 1955), Kilbride, near Campbelltown, Porter's Retreat, and Adaminaby (Copland, 1957).

AUSTRALIAN CAPITAL TERRITORY RECORDS

The Australian Museum has specimens from:

"ACT" (Nos. 12494-12495)

The American Museum of Natural History has a specimen from:
Canberra (No. 64093)

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Byfield, near Yeppoon (No. 8700)

*Queensland (No. 5259, old collection)

The American Museum of Natural History has specimens from:

Binna Burra, Beechmont (Nos. 64075-64080)

The British Museum (Natural History) has specimens from:

Cooktown (Nos. 98.10.19.21, 98.10.19.22)

Port Denison (Nos. 64.7.8.11, 64.7.8.12)

Hyla ewingi is very common in southeastern Australia. One wonders why it is infrequent in collections from Queensland, where it is widely distributed. New data on its status in central and northern Queensland are desirable.

VICTORIA RECORDS

The Australian Museum has specimens from:

Tom Groggin (No. 12983)

Ballarat (Nos. 8339, 8340, 8395)

Warragul (No. 8408)

*Mt. Lofty (No. 8414)

Copland (1957) suggests that the Mt. "Lofty" locality may be in South Australia.

The American Museum of Natural History has specimens from:

Olinda (Nos. 64082-64092)

The British Museum (Natural History) has specimens from:

Ballarat (No. 92.9.16.7)

Melbourne (No. 63.11.16.8)

Localities for which I have literature records only are: Little River between Buchan and the New South Wales border (Brazenor, 1947); 18 miles west of Bairnsdale, Darby on

Wilson's Promontory, Mt. Donna Buang, Mt. Baw Baw, and Grampians (Copland, 1957); Ringwood, Brighton, Waterloo, Trafalgar, and Bairnsdale (Lucas, 1892); and the Bogong High Plains (Garnet, 1959).

TASMANIA RECORDS

The Australian Museum has specimens from:

Flinder's Island, Bass Strait (Nos. 6070, 6071)

*Pierman's Ridge, northwest Tasmania (No. 12121)

Port Sorell (No. 7469)

Ulverstone (Nos. 7470, 7603-7610)

Launceston (No. 6046)

Cradle Lake (No. 9830)

Lake St. Clair (No. 12122)

Interlaken (Nos. 9500, 9501)

Hobart (No. 4402)

Cascades (No. 10073)

Dinorlan (No. 10955)

*Tasmania (Nos. 5260, 8403, 8416, 8419)

The American Museum of Natural History has specimens from:

Arthur River (Nos. 64094-64096)

Lake St. Clair (Nos. 64099-64107)

Derwent Bridge (Nos. 64097, 64098)

The British Museum (Natural History) has specimens from:

Launceston (Nos. 1901.9.13.40-1901.9.13.49)

Longford (No. 1936.7.9.11)

Hobart (Nos. 46.9.11.62, 43.8.24.19)

Near Hobart (Nos. 1936.9.7.8-1936.9.7.10)

Tasmania (Nos. 60.11.29.26, 45.5.2.33, 45.3.31.33, and 52.12.11.3, recatalogued as No. 1947.2.22.75, one of the types)

Localities for which I have only literature records are Kingston (Copland, 1957); Lake Tiberias (Lord and Scott, 1924); St Peter's River (Loveridge, 1935); Lake Fenton, Eaglehawk Neck, Port Arthur, Wilmot, Sheffield (Blanchard, 1939); and Westbury and Devonport (English, 1910).

SOUTH AUSTRALIA RECORDS

The Australian Museum has specimens from:

Kingscote, Kangaroo Island (Nos. 7128, 7149, 7160, 7163)

*South Australia (No. 5257)

Adelaide is the type locality of *Hyla callis-*
celis (Peters, 1875) a synonym.

WESTERN AUSTRALIA RECORDS

The British Museum (Natural History) has two specimens (Nos. 64.10.27.23, 64.10.27.24) received from Krefft that are probably *Hyla ewingi*. They are listed as such by Boulenger (1882). The locality is given as King George's Sound. This is the only record for this species in Western Australia. Main (1954a) did not list it. I have not entered this record on the map of distribution (fig. 58), because I doubt its validity.

LITERATURE

Hyla ewingi was described by Duméril and Bibron (1841). The type locality is Van Diemen's Land. One of the types is in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)], and the other is in the British Museum (Natural History).

Hyla calliscelis was described from Adelaide by Peters (1875). Boulenger (1882) and later authors have regarded it as a synonym of *Hyla ewingi*, or at most a subspecies. *Hyla verreauxi* was described by Duméril (1853) on the basis of 14 individuals from Botany Bay and Sydney. These are listed as Nos. 4849 and 4850 in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)]. This is also a synonym, or at most is the name of a subspecies.

General descriptions are given by Jacquinet and Guichenot (1853, with a colored illustration of the adult and the roof of the mouth), Günther (1858, as *Hyla ewingi* and also as *Hyla verreauxi*), Keferstein (1868a, and with a mention of *Hyla verreauxi*), Steindachner ("1869" [1867]), Krefft (1870, also as *Hyla verreauxi*), Boulenger (1882), Fletcher (1892; 1898, with a description of a new variety from eastern New South Wales, *Hyla ewingi orientalis*), Lucas and Le Souëf (1909), Fry (1915, with descriptions and illustrations of a new subspecies from Mt. Kosciusko, *Hyla ewingi alpina*), Nieden (1923), Lord and Scott (1924), Waite (1929), Loveridge (1934, as *Hyla ewingi* and *Hyla jervisiensis*; 1935, with *Hyla ewingi orientalis* becoming *Hyla ewingi verreauxi*), Slevin (1955), and Copland (1957, with descriptions of *Hyla ewingi iuxtaewingi* from 18 miles west of Bairnsdale, Victoria, and of *Hyla ewingi loveridgei* from near Porter's Retreat, New South Wales). Condon's (1941, with figures of the adult)

description of *Hyla jervisiensis* most likely applies to *Hyla ewingi*.

Descriptions of the habits can be found in Fletcher (1889), English (1910, with colored illustrations of the adults), Harrison (1922), and Blanchard (1929). In referring to the habits of this species, Krefft (1863) probably used three names, *Hyla ewingi*, *Hyla verreauxi*, and *Hyla krefftii*.

Various other discussions are: of the trematode parasites, by Johnston (1912); of the skull, by William K. Parker (1881, with illustrations); of the hyoid and larynx, by Trewavas (1933); and of the color of the ovum, by Harrison (1921). Marriner (1907) gives an account of the introduction of *Hyla ewingi* into New Zealand.

Geographical data are given by Günther (1867), Fletcher (1890, 1891a, 1894b), Lucas (1892, 1897), Andersson (1913a, also a discussion of *Hyla calliscelis*), Kinghorn (1924), and Brazenor (1947).

There are unimportant references to *Hyla ewingi* in Gray (1841a), Duméril (1853), Duméril and Bibron (1854), Krefft (1865, 1867, 1869, also with mention of *Hyla verreauxi*), Anonymous (1883), Spencer (1892, also a mention of *Hyla verreauxi*), Aflalo (1896), Gadow (1901), Fry (1912), Smith (1929), Scott (1942), and Moore (1957a).

Hyla parvidens Peters (1875) and *Hyla inguinalis* Ahl (1935) are probably synonyms of *Hyla ewingi*.

THE GROUND HYLAS

The species of *Hyla* that remain to be considered are not "tree" frogs. They are terrestrial and *Rana*-like in general habits. During much of the nineteenth century the generic name *Litoria* Tschudi was used for many of them. In Boulenger's (1882) "Catalogue," however, *Litoria* was regarded as a synonym of *Hyla*, and it has remained so to this day.

In Australia there are two species groups of terrestrial hylas, namely, the *lesueuri* group and the *aurea* group. These groups are very different from each other in spite of the fact that both are terrestrial.

The *lesueuri* group is discussed first. Its five species form a sequence that begins with stout-bodied and broad-headed forms and gradually passes to those with extremely

slender bodies, long legs, and narrow heads.

The first member of the group is a new species, and in several respects it links the other *lesueuri*-like species with the more typical tree frogs.

Hyla booroolongensis, new species

THE BOOROOLONG FROG

Plate 45, figure 1; text figures 59, 60

Hyla X COPLAND, 1957, p. 87.

?*Hyla* sp. FLETCHER, 1894b, p. 528 (Inverell).

HOLOTYPE: Australian Museum No. 16006 (formerly A.M.N.H. No. 64816), the female of a clasping pair collected at Guy Fawkes Creek, Ebor, New South Wales, November 21, 1952, by John A. Moore; altitude 4200 feet; field number 318.

PARATYPES: A.M.N.H. No. 64814 (the male that was in amplexus with the type) and Nos. 64810-64813 and 64815 collected November 20 and 21, 1952, at Guy Fawkes Creek, Ebor, New South Wales. British Museum (Natural History) No. 1958.1.1.7 collected at Guy Fawkes Creek on November 20, 1952. A.M.N.H. Nos. 64807-64809, males collected at Booroolong Creek, 20 miles northwest of Armidale, New South Wales, on November 17, 1952, altitude 3500 feet. All collected by John A. Moore.

DIAGNOSIS

This new species is one of the *Hyla lesueuri* group, that is, it is primarily a terrestrial form with small discs on the fingers and toes, a very short second finger, a dark band across the dorsal side of the wrist, no finger webs, and vomerine teeth between the choanae.

It differs from other members of the *Hyla lesueuri* group in many ways, as are summarized in table 6. It is most similar to *Hyla lesueuri* itself, but it differs in having larger discs on the fingers, the second finger always slightly longer than the first, the fifth toe webbed to the disc, a more rounded head, no dark stripe below the canthus (or a very inconspicuous one), and a shorter tibia. In addition it is a smaller species. Most breeding females of *Hyla booroolongensis* are less than 50 mm. in body length (most of those of *Hyla lesueuri* are more than 50 mm.), and most of the males are less than 35 mm. (most of the males of *Hyla lesueuri* are more than 35 mm.).

DESCRIPTION

The holotype is a breeding female, with a body length of 45.7 mm., tibia length of 25.1, head length of 16.4, and head width of 17.3. The upper parts are grayish brown, with an indistinct darker mottling. There is, in fact, no distinctive pattern anywhere on the body. The hind surface of the thigh is dark brown, with small pale spots. The under parts are white.

The dorsal surface is nearly smooth, with a few very flattened warts. The throat is smooth, and the rest of the under parts is granular. There is a poorly developed chest fold.

The snout, when viewed from above, is more rounded than in *Hyla lesueuri*. When viewed laterally it is also rounded. The nostrils are nearer to the end of the snout than to the eyes. The canthus is rounded, and the loreal region is slightly concave. There is a feebly developed ridge behind the eye. The tympanic membrane is moderately distinct and about the same color as the side of the head. In the other members of the *lesueuri* group, the tympanum is more distinct, as in most specimens it differs in color from the surrounding skin.

The fingers are not webbed (fig. 59). The discs are much wider than the fingers. The tubercles of the hand are moderately developed. The outer metacarpal tubercle is split for half of its length. The sequence of finger lengths is $3 > 4 > 2 > 1$. The second finger is definitely longer than the first. The thumb is opposable.

The toes have well-developed webs (fig. 59). Only the disc of the fifth toe is free. The disc and one phalanx of the fourth toe are free. The inner metatarsal tubercle is moderately developed, and there is a tiny outer metatarsal tubercle.

The vomerine teeth are in two transverse series that are contiguous (fig. 59). They are between the choanae, their anterior borders being level with the anterior borders of the choanae.

The tongue is broad and has a slight nick on the hind border.

Males are much smaller than females. The male (A.M.N.H. No. 64814) that was in amplexus with the holotype has a body length of 34.5 mm., tibia length of 18.6, head length of

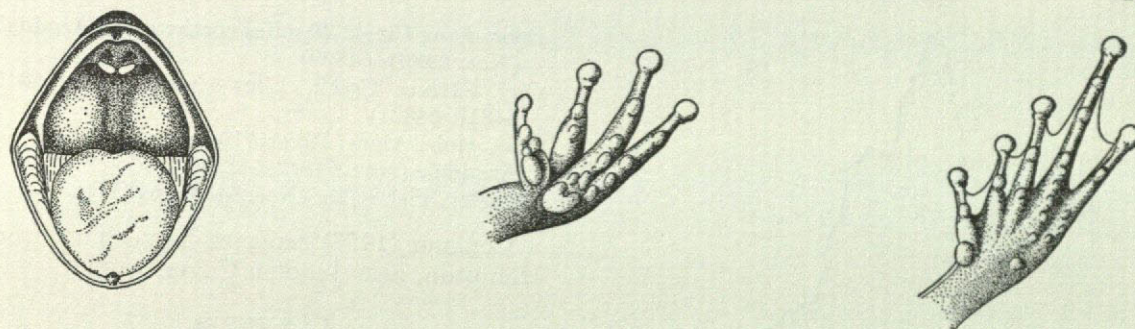


FIG. 59. *Hyla booroolongensis*. Open mouth, hand, and foot. A.M.N.H. No. 64816. Ebor, New South Wales. Holotype.

12.9, and head width of 13.6. A dark brown nuptial pad covers nearly all the dorsal and inner sides of the thumb.

In coloration and body form this male closely resembles the female holotype. The vomerine teeth differ in being nearly circular and in not touching at the midline. They are slightly more posterior, their hind ends being a little more posterior than the posterior level of the choanae.

The other paratypes in the American Museum series agree closely with the holotype and the mate of the holotype, but the following points should be mentioned. The posterior borders of the vomerine in most specimens are behind the level of the choanae. The posterior surface of the thigh may lack the modest pattern of the type and be like the rest of the dorsal surface. Many individuals have a dark band across the top of the wrist, a common feature in species of the *lesueuri* group.

The following measurements are for the holotype and paratypes. The six females vary in body length from 45.7 to 50.5 mm. Their body proportion ratios are: tibia length/body length, 0.54 ± 0.00 (0.53–0.56); head length/body length, 0.34 ± 0.00 (0.34–0.36); head width/head length, 1.08 ± 0.01 (1.05–1.10). The four males vary from 31.3 to 37.0 mm. Their ratios are: tibia length/body length, 0.56 ± 0.01 (0.54–0.56); head length/body length, 0.36 ± 0.01 (0.33–0.38); head width/head length, 1.07 ± 0.02 (1.02–1.11).

The Australian Museum has a large series from the Fish River at Tarana, New South Wales (Nos. 3125–3135). The 11 males with nuptial pads vary from 25.5 to 32.3 mm. in body length. Excluding the obviously immature ones, there are six females that vary

from 37.4 to 44.4 mm. As the tibia length/body length ratio is the most useful ratio for separating *Hyla booroolongensis* from *Hyla lesueuri*, it might be mentioned that for the males of the Fish River series it is 0.56 ± 0.00 (0.55–0.58), and for the females 0.57 ± 0.01 (0.55–0.59).

The largest female that I have seen has a body length of 50.5 mm. (A.M.N.H. No. 64810, Ebor, New South Wales), and the largest male is 38.5 mm. (Australian Museum No. 5935, Penrose Farm, Macquaire River, 8 miles from Bathurst, New South Wales).

HABITAT

Hyla booroolongensis was first encountered at Booroolong Creek, near Armidale, New South Wales (pl. 28, fig. 2). It was later taken at Guy Fawkes Creek, Ebor, New South Wales (pl. 28, fig. 1). Both are slow-moving streams with grassy borders.

At Guy Fawkes Creek the adults were abundant at night, sitting on the rocks in the stream and on the banks. Booroolong Creek was visited only during the day. Here the adults were found under stones within 10 feet of the creek.

VOICE

The call is a soft, slow "qrk qrk qrk."

BREEDING HABITS

Mating pairs were observed in Guy Fawkes Creek during the night of November 20 and 21, 1952. Claspings is in the pectoral position.

GEOGRAPHIC DISTRIBUTION

Hyla booroolongensis is an upland species. It extends from the Armidale region to the Blue Mountains in New South Wales (fig.

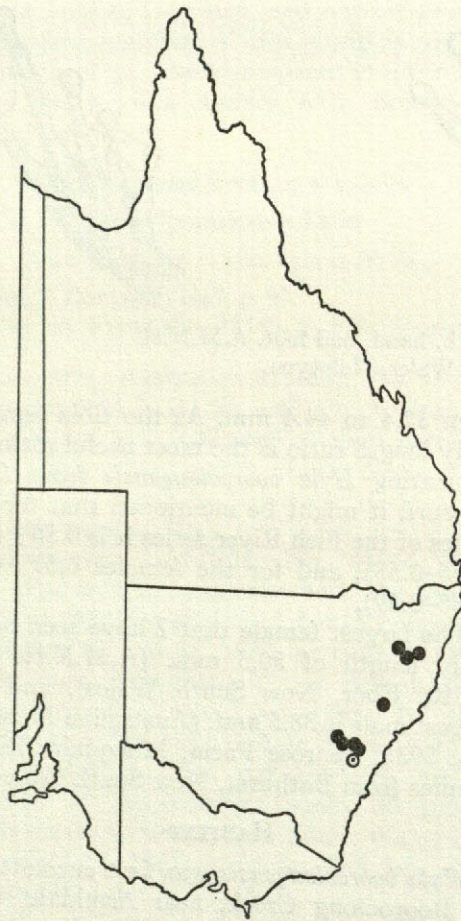


FIG. 60. *Hyla booroolongensis*. Geographic distribution.

60). The type locality is Guy Fawkes Creek, Ebor, New South Wales.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:
 Ebor (No. 16006, holotype)
 Salisbury (No. 10963)
 *Williams River (Nos. 9224, 9225, 9230, 9233, 9236)
 Penrose Farm, Macquaire River, 8 miles from Bathurst (Nos. 5929–5943, 6269, 6701–6715)
 Tarana (Nos. 3198, 3199)
 Tarana, Fish River (Nos. 3125–3135)
 Bowenfels, Cox River (Nos. 13378–13381)
 Katoomba, The Valley (Nos. 4215–4219)
 Katoomba, Megalong Valley (Nos. 5189–5196)
 Kinimbla Valley, Blue Mountains (Nos. 7457–7462)

The American Museum of Natural History has specimens from:

Booroolong Creek, 20 miles northwest of Armidale (Nos. 64801–64809)

Guy Fawkes Creek, Ebor (Nos. 64810–64815, 64817–64821)

Blue Hole, Gara River, 10 miles southeast of Armidale (Nos. 64822–64832)

Locksley, Fish River (Nos. 64833, 64834)

Copland (1957) reported a specimen from Hampton, near Jenolan Caves.

COMMENTS

Fletcher (1894b) says, in a footnote about an unfamiliar *Hyla* from Inverell: "A marbled or spotted frog (one specimen: six others in the mixed collection from Tamworth and Armidale) I have not previously met with. From the free fingers, the vomerine teeth, and the webbing of the toes, I should refer it to the marbled form of *H. lesueurii*." This reference may be to *Hyla booroolongensis*. Unfortunately, the specimens referred to do not seem to be in the Australian Museum, so the point cannot be established.

The Australian Museum does have a number of individuals of *Hyla booroolongensis* which I found when studying its collections. Copland (1957) has examined these and also believes them to be a new species. He gives a long account and, most courteously, refers to them simply as *Hyla* X, while awaiting my long-overdue description.

***Hyla lesueuri* Duméril and Bibron**

LESUEUR'S FROG

Plate 45, figure 4; text figures 61, 62

DIAGNOSIS

A combination of the following characteristics separates this species from all others in eastern New South Wales: very small discs on fingers and toes; a large outer metatarsal tubercle and a small central one; first and second fingers equal in length; posterior surface of thigh black with pale blue spots when alive.

This species is most likely to be confused with the other members of the *lesueuri* group; table 6 shows how it can be distinguished.

Apart from the members of the *lesueuri* complex, this species can be confused only with *Hyla citropa*. However, the small discs (large in *Hyla citropa*), the black coloration of the posterior surface of the thigh (pale in

Hyla citropa), and the fact that the anterior edge of the vomerine teeth are at the level of the anterior edge of the choanae (near the posterior edge of the choanae in *Hyla citropa*) afford easy separation.

DESCRIPTION

This description is based on individuals from the vicinity of Sydney, the type locality. The background color of the dorsal surface, including the appendages, varies from dark brown to olive-brown. There are usually some obscure darker blotches on the back. A narrow dark stripe begins on the snout and extends just below the canthus to the eye. Posterior to the eye a similar stripe extends across the top of the tympanic membrane and along the side of the body. Posterior to the level of the arm it breaks into a series of blotches that extend to the groin.

The posterior surface of the thigh is black, with numerous bluish white spots or blotches. These are small in some individuals and large in others. The anterior surface of the thigh is grayish brown, with pale bluish blotches.

There is a dark band across the top of the wrist. This is difficult to see in individuals that are in a dark phase.

The edges of the upper and lower jaw are dark, with a few white spots. The upper half of the iris is golden, and the lower half is silver.

The ventral surface is white, except for the throat which is mottled with brown.

The dorsal surface is smooth or slightly roughened. The ventral surface is smooth in the throat region and faintly granular posterior to the pectoral girdle.

Hyla lesueuri has a broad head and long legs. There is considerable sexual dimorphism in size and, to a lesser extent, in body proportions. The following measurements are based on six adult females and 10 adult males (with nuptial pads) collected at Killara, National Park, and the Grosse River near Blackheath (all New South Wales). The females vary from 51.9 to 57.2 mm. in body length; the tibia length/body length ratio is 0.63 ± 0.01 (0.60–0.65); the head length/body length ratio is 0.35 ± 0.00 (0.34–0.36); and the head width/head length ratio is 1.06 ± 0.01 (1.02–1.09). Comparable data for the males are: body length, 33.7–40.8 mm.; tibia length/

body length, 0.63 ± 0.00 (0.61–0.65); head length/body length, 0.37 ± 0.00 (0.37–0.38); head width/head length, 1.04 ± 0.01 (1.02–1.07).

The largest female that I have seen is 67.5 mm. (Australian Museum No. 7500, from Dunoon on the Richmond River). The largest male is 44.4 mm. (Australian Museum No. 6049, from Norton's Basin, Nepean River).

The types are two individuals in the Muséum National d'Histoire Naturelle in Paris. Each is labeled "*Hyla lesueuri*. P. Jackson: Péron-Lesueur." Measurements in millimeters of No. 4845 are: body length, 38.7; tibia length, 23.8; head length, 14.2; head width, 15.6; and of No. 4846 are: body length, 39.4; tibia length, 23.5; head length, 14.3; head width, 15.0.

The canthus is a sharp ridge. This ridge continues posterior to the eye and extends above the tympanum to the level of the arm. It overhangs the posterodorsal portion of the tympanum. The tympanum itself is conspicuous.

There are no webs between the fingers (fig. 61). The second finger is short, as in all members of the *lesueuri* species group. The sequence of lengths is $3 > 4 > 2 = 1$ for the most part, but in some individuals the second finger is very slightly longer than the first. The tubercles on the palm are well developed.

The toes have a well-developed web (fig. 61). The disc and one or two phalanges of the fourth toe are free. The disc and from one-quarter to all of the distal phalanx of the fifth toe are free. The inner metatarsal tubercle is moderately developed, and there is a tiny central metatarsal tubercle.

The tongue is broad and has a posterior nick. The vomerine teeth are between the choanae, their anterior edge being level with the anterior edge of the choanae (fig. 61).

An individual collected at Eden, New South Wales, has a huge parasite, which I take to be *Batrachomyia*, under the skin of the back.

HABITAT

I encountered *Hyla lesueuri* along streams and rivers with sandy banks. At Killara, New South Wales, it was found only along a stream that flows into Middle Harbor. At night the adults sat on the bank, each in a

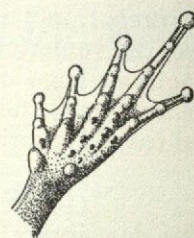
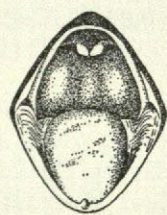


FIG. 61. *Hyla lesueuri*. Open mouth, hand, and foot. A.M.N.H.
No. 64126. National Park, New South Wales.

slight depression in the sand, with the head down. Usually they made no attempt to move, and could be approached easily and picked up. At other times I have found them much more active. When they do move, they are among the best of the New South Wales frogs in jumping ability. In this respect they exceed *Hyla aurea*.

Fletcher (1889) reports that they are abroad by day and remarks on the excellence of their protective coloration.

VOICE

The males have a peculiar soft call that I found difficult to hear beyond 10 feet. Once I described it as a soft, purring "gr-i-i-i-ck" or "gr-r-r-r-r-r," each call lasting two or three seconds. Another time it was described as a purring "err-err-err-err."

EMBRYONIC DEVELOPMENT

Some tadpoles of *Hyla lesueuri* were collected at Eden, New South Wales, on February 17, 1953. Their identity was established by my raising them to metamorphosis.

To the eye the fully grown tadpoles appear to be mottled gray on the dorsal surface, but under the microscope the back is seen to have black spots showing through an almost continuous layer of golden chromatophores. The head region is less heavily pigmented. There is an almost continuous layer of golden cells on the ventral side. The myotome area of the tail has some spots of melanophores, but the fins are almost without pigment.

The mouth is directed ventrally and is surrounded by a continuous circle of papillae. There are two complete rows of teeth in front of the mouth and three complete rows behind. The spiracle is on the left, and the anus opens to the right. The largest of these tadpoles, before metamorphosis, was 34 mm.

GEOGRAPHIC DISTRIBUTION

Hyla lesueuri occurs in eastern Australia from northern Queensland to Victoria (fig. 62). The type locality is Port Jackson (= Sydney).

I do not find it possible to give a satisfactory account of the distribution of this species outside New South Wales. In Queensland there is a complex situation. Some specimens are conspecific with the Sydney *Hyla lesueuri*. Others appear to be similar to *Hyla lesueuri*, but I suspect that they are an unrecognized species.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Tyalgum, Tweed River (Nos. 11155-11158)
Huonbrook (No. 11862)
Dunoon, Richmond River (Nos. 7498-7500)
Tenterfield (No. 13111)
Horton River, Near Bingarah (No. 4637)
Lowana, Dorrigo (Nos. 12657-12672, 12745)
Brooklana, east of Dorrigo (No. 9948)
Williams River (No. 9216)
Upper Colo, via [near] Richmond (Nos. 7968, 7970, 7971)
Wellington (No. 55)
Hartley, Blue Mountains (No. 10299)
Lindfield (No. 4480)
Sydney (No. 7011, old collection)
Thirroul (Nos. 5372-5374)
Norton's Basin, Nepean River (Nos. 6049-6052, 6054-6057)
Burrawang (Nos. 7381-7383)
Wagga Wagga (No. 7362, old collection)
Broggo River (No. 12275)

The American Museum of Natural History has specimens from:

Blue Hole, Gara River, 10 miles southeast of Armidale (No. 64835)
Tooloom Falls, near Urbenville (Nos. 64139-64141)

Grosse River, near Blackheath (Nos. 64108–64116)

Killara (Nos. 64117–64124)

National Park (Nos. 64126–64128)

Lawler's Creek, near Bodalla (No. 64125)

Delegate (No. 64293)

Eden (Nos. 64129–64138)

The British Museum (Natural History) has specimens from:

Clarence River (Nos. 64.7.6.6, 64.7.6.7, recatalogued as Nos. 1947.2.22.76, 1947.2.22.77; types of *Litoria wilcoxii*; No. 64.10.27.22)

Guntawang, near Mudgee (Nos. 88.7.3.19, 88.7.3.20)

Springwood (No. 88.7.3.18)

Sydney (Nos. 54.7.6.1, 1935.1.5.1)

Illawarra (No. 88.7.3.21)

Nowra (No. 1931.1.5.1)

No locality (No. 64.10.27.26)

There are literature records for Tamworth (Fletcher, 1894b), Comboyne Plateau (Chisholm, 1926), Salisbury (Loveridge, 1935), Yarramalong, Myall Lakes, Nymboida, Bombala, and 28 miles from Armidale on Bundarra Road (Copland, 1957).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Atherton (No. 10094)

Eidsvold (Nos. 5325, 6180, 6181)

Brisbane (Nos. 5604, 5868)

Pimpana (No. 7410)

Waroo, Inglewood (Nos. 7419, 7422–7426)

The American Museum of Natural History has specimens from:

Ravenshoe (Nos. 19935–19938, 19940, 19943, 19950)

*Queensland (No. 23973)

The British Museum (Natural History) has specimens from:

Port Mackay (Nos. 85.9.2.46, 85.9.2.47)

Port Curtis (No. 64.10.27.31)

There are literature records for Rockhampton (Peters, 1873b), Coomooboolaroo (Slevin, 1955), Thane Creek west of Warwick, 5 miles west of Gayndah, 10 miles northwest of Mundubbera, Wowan, and 23 miles north of Gin Gin (Copland, 1957).

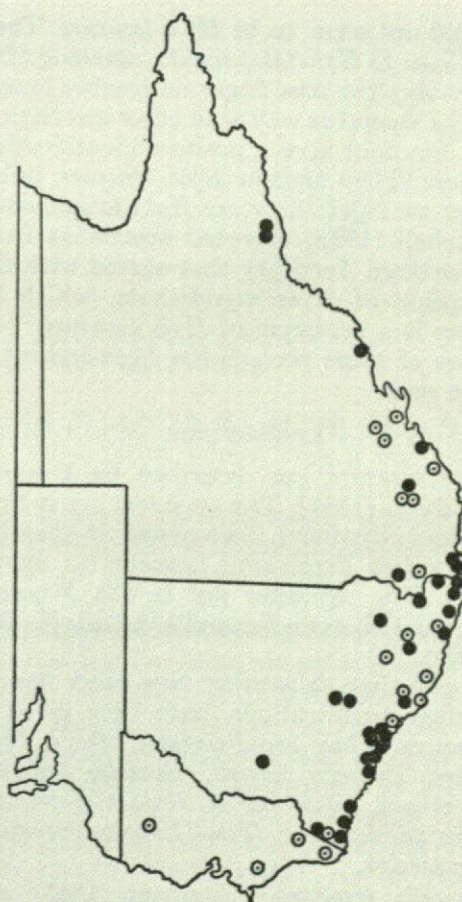


FIG. 62. *Hyla lesueuri*. Geographic distribution.

VICTORIA RECORDS

There are reports in the literature of the occurrence of *Hyla lesueuri* at M'Allister and Wellington rivers (Lucas, 1892), Honeysuckle Track, near Gelantipy (Brazenor, 1947), 22 miles north of Cann River Township, and Horsham (Copland, 1957).

NORTHERN TERRITORY RECORDS

Hyla lesueuri has been reported from the Northern Territory (Copland, 1957) on the basis of specimens in the Australian Museum, such as Nos. A4914, A4916, A4918, and A4921 (from Yam Creek, 100 miles inland from Port Darwin), and R9729, R9730, and R9733–R9735 (from Groote Eylandt). These were originally listed in the collection as *Hyla nigrofrenata*, regarded by many as a synonym of *Hyla lesueuri*. I studied these in 1953, and

they did not seem to be *Hyla lesueuri*. They were closer to *Hyla latopalmata*, agreeing with it in having the first finger noticeably longer than the second as well as in other less critical ways. I cannot give a positive identification for these. They are not *Hyla lesueuri*, but I am not sure that they are *Hyla latopalmata*.

Mitchell (1955) reported specimens from the Northern Territory that agreed with the description of *Hyla nigrofrenata*, which he believes is a synonym of *Hyla lesueuri*.

None of these records has been indicated on the map.

LITERATURE

Hyla lesueuri was described by Duméril and Bibron (1841). The type locality is Port Jackson (=Sydney). As a synonym they list *Hyla oculata* Péron and Lesueur (in manuscript). The syntypes are in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)].

At one time or another nine other names, and their modifications, have been listed as synonyms. They are *Pelodytes affinis*, *Hyla tornieri*, *Euscelis lessoni*, *Euscelis lesueuri*, *Hyla vinosa*, *Litoria copei*, *Hyla nigrofrenata*, *Litoria wilcoxi*, and *Hyla (Litoria) freycineti* var. *unicolor*.

Euscelis lesueurii (Fitzinger, 1843) and *Euscelis lessoni* (Fitzinger, 1861) were new names for *Hyla lesueuri*. They are synonyms and present no special problems.

Litoria wilcoxi was described by Günther (1864a, 1864b; identical descriptions); the type locality is the Clarence River of New South Wales. It was referred to subsequently by Günther (1867, 1868a, 1868b), Keferstein (1868a), and Krefft (1865, 1867, 1870). Boulenger (1882) listed the types as *Hyla lesueuri*. They are in the British Museum where I examined them. I agree with Boulenger.

Hyla (Litoria) freycineti var. *unicolor* (Keferstein, 1867) was later said to be *Hyla lesueuri* (Keferstein, 1868a).

So far as the other names are concerned, I am not at all sure that they are synonyms of *Hyla lesueuri*. They are discussed below either in connection with *Hyla latopalmata* or in the concluding section on the *lesueuri* group.

Ranoidea flavoviridis of Girard (1853) has generally been forgotten, although Kefer-

stein (1868a) did believe it to be a synonym of *Hyla aurea*. The United States National Museum has two specimens listed as the types. The larger of the two, No. 15484, is *Hyla lesueuri*. The other, No. 15485, which is small and in very poor condition, is neither *Hyla lesueuri* nor *Hyla aurea*. I am unable to give a positive identification.

Descriptions of *Hyla lesueuri* are given by Keferstein (1868a, with figures of the adult and the roof of the mouth), Steindachner ("1869" [1867]), Peters (1873b, as *Litoria lesueuri*), Boettger (1894), Lucas and Le Souëf (1909), Nieden (1923), Loveridge (1935), Slevin (1955, with a photograph of an adult), Moore (1957, with a photograph of an adult), and Copland (1957).

The excretory system is discussed by Sweet (1908), the parasites are discussed by Johnston (1912), and the scapula is discussed by Procter (1921).

References that consist primarily of distributional data are: Fletcher (1890, 1892, 1894b), Boettger (1892), Lucas (1892), Roth (1908), Andersson (1916), Procter (1923), Chisholm (1926, as *Hyla leseurii*), Mitchell (1955, probably referring to a different species), and Brazenor (1947).

Minor mention is made in Gray (1841a), Duméril (1853), Aflalo (1896), Lucas (1897), Fry (1912, 1915), and Andersson (1913a).

Hyla latopalmata (Günther)

GÜNTHER'S FROG

Plate 45, figure 3; text figures 63, 64

DIAGNOSIS

The very small discs on the fingers and toes, the absence of webbing between the fingers, the very short second finger, the dark band across the dorsal side of the wrist, and the position of the vomerine teeth between the choanae, show that *Hyla latopalmata* is a member of the *lesueuri* group. It can be distinguished from the other New South Wales members of this complex by the possession of the following characteristics: a dark band extending from the eye through the tympanum (as wide as the tympanum) and ending at the level of the arm; the dorsal surface without prominent warts or ridges; the outer metacarpal tubercle not obviously nicked or split; the first finger slightly but

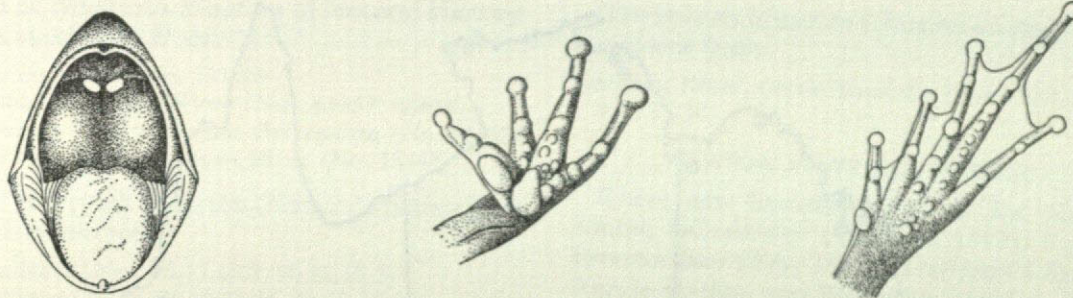


FIG. 63. *Hyla latopalmata*. Open mouth, hand, and foot. A.M.N.H. No. 63859. Dandaloo, Bogan River, New South Wales.

definitely longer than the second. (See also table 6.)

DESCRIPTION

The upper parts are pale grayish brown, with a few small and relatively inconspicuous dark blotches. In several specimens there is a butterfly-shaped blotch between the eyes, reminding one of a similar marking in *Adelotus brevis*. A black band extends from the nose to the eye and from the eye through the tympanic membrane back to the level of the arm. Posterior to the arm, the band terminates as a few spots. Several details about this band are important for distinguishing *Hyla latopalmata* from other species of the *lesueuri* complex. First, it is as wide as the tympanic membrane. Second, there is a vertical, white bar immediately in front of the eye that nearly sunder the black band. Third, the band ends posteriorly at the level of the arm.

The edges of the upper and lower jaws are dark, with moderately regular white spots, giving the jaws a cross-hatched appearance.

The anterior surface of the thigh is yellowish. There is usually an irregular dark stripe or a series of irregular spots between the yellow area and the grayish brown dorsal coloration. The posterior surface of the thigh is yellow, with an irregular black reticulum.

The under parts are white, except for the throat, which is dusky.

The skin of the dorsal surface is smooth or has a few low, elongate warts. The abdominal region is faintly granular. There is a moderately well-developed chest fold.

This is a medium-sized frog, with moderately long legs and a moderately narrow head. The largest individual that I have seen is a

female (A.M.N.H. No. 63858), from Dandaloo, New South Wales, with a body length of 42.5 mm. Measurements were made on 15 individuals in the Australian Museum from the Darling River, Dandaloo, and Norton's Basin on the Nepean River in New South Wales and Eidsvold, in Queensland. Their body lengths vary from 34.4 to 42.5 mm. The body proportion ratios are: tibia length/body length, 0.63 ± 0.01 (0.57–0.70); head length/body length, 0.37 ± 0.00 (0.34–0.39); head width/head length, 0.98 ± 0.02 (0.89–1.11).

Measurements in millimeters of the syntypes in the British Museum (Nos. 64.10.27.47, 64.10.27.48, recatalogued as Nos. 1947.2.24.27, 1957.2.24.28) are as follows: First specimen: body length, 37.2; tibia length, 22.6; head length, 13.4; head width, 12.7. Second specimen: body length, 28.7; tibia length, 17.3; head length, 10.7; head width, 10.7.

The tympanic membrane is very distinct. The canthus is moderately sharp, and the loreal region is slightly concave.

The fingers are not webbed (fig. 63). The thumb is opposable. The outer metacarpal tubercle is not nicked. The sequence of finger lengths is $3 > 4 > 1 > 2$.

The toes are moderately webbed (fig. 63). The disc and one and a half or two phalanges of the fourth toe and the disc and about one-half of a phalanx of the fifth toe are free. There are a small inner metatarsal tubercle and a minute outer metatarsal tubercle.

The vomerine teeth are between the choanae (fig. 63). Their anterior borders are level with the anterior borders of the choanae. The tongue is broad and has a nick on the posterior margin.

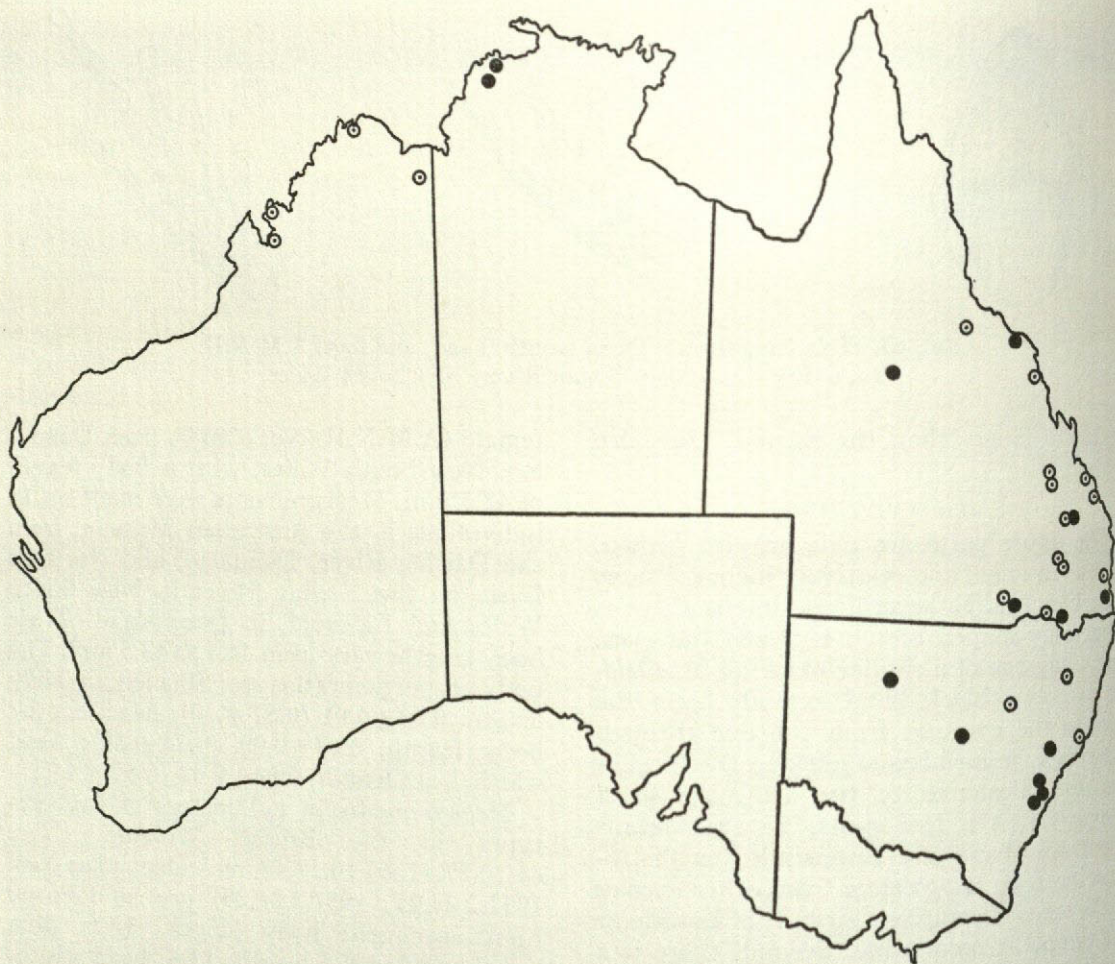


FIG. 64. *Hyla latopalmata*. Geographic distribution.

HABITAT

Hyla latopalmata ranges across Australia and occurs in a variety of habitats from the arid zone of the interior to the moist areas of eastern Queensland.

I encountered it only twice. One locality was in a grassy area several hundred yards from Prospect Reservoir, near Parramatta, New South Wales. On the other occasion it was beneath stones adjacent to a pool in an almost dry creek near Rainsby, Aramac, Queensland (near the site shown in pl. 31, fig. 1).

I have no first-hand information on the breeding habits of this species.

Fletcher (1889) says that *Hyla latopalmata* can be seen abroad by day.

Harrison (1922) "collected a series of young ones, which had just completed their

metamorphosis, on the edge of a large heath swamp at Nelson's Bay, Pt. Stephens, in January, 1920."

GEOGRAPHIC DISTRIBUTION

Hyla latopalmata extends across northern Australia from the Kimberleys to the Queensland coast and south in New South Wales to the vicinity of Sydney (fig. 64). The type locality is Port Denison (= Bowen), Queensland.

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

Darling River (Nos. 4301-4305, 4307)
Dandaloo, Bogan River (Nos. 7465, 7467, 7468)
Gouldsville, 10 miles from Singleton (No. 8699)
Nepean River (Nos. 8469, 8470)
Norton's Basin, Nepean River (Nos. 6059-6061)

The American Museum of Natural History has specimens from:

Darling River (No. 13346)
Dandaloo, Bogan River (Nos. 63858, 63859)
Prospect Reservoir, near Parramatta (No. 64292)
Norton's Basin, Nepean River (No. 13347)

The British Museum (Natural History) has specimens from:

Dandaloo (Nos. 90.12.18.2, 90.12.18.3)
Richmond (Nos. 64.10.27.35, 64.10.27.36)
"S. Creek," Sydney (No. 88.7.3.17)

There are literature records for 9 miles south of Coonabarabran, Failford, and 28 miles from Armidale on the Bundarra Road (Copland, 1957).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

Eidsvold, Burnett River (Nos. 5342-5345, 5347, 5501, 5502, 5827, 6331)
Brisbane (No. 5867)
Waroo, Inglewood (No. 7414)

The American Museum of Natural History has specimens from:

Rainsby Station, Aramac (Nos. 64290, 64291)

The British Museum (Natural History) has specimens from:

Port Denison (Nos. 64.10.27.47, 64.10.27.48, recatalogued as Nos. 1947.2.24.27, 1947.2.24.28; types)
Brisbane (Nos. 64.7.6.8, 64.7.6.9)
Moonie River, St. George District (No. 1923.11.12.1)
*Queensland (No. 66.12.28.14)

There are literature records for Rutherford on the Sellheim River (Loveridge, 1935), 10 miles southwest of St. George, 12 miles south of Boggabilla, Condamine River near Chinchilla, Condamine River near Warra, 21 miles west of Eidsvold, Baralaba, 11 miles north of Moura, Takilberan Creek 23 miles north of Gin Gin, 8 miles southeast of Calliope, Burpengary, and Mackay (Copland, 1957).

NORTHERN TERRITORY RECORDS

The American Museum of Natural History has a specimen from:

Koolpingah Station, 30 miles south of Darwin (No. 33835)

The British Museum (Natural History) has specimens from:

Adelaide River, north Australia (Nos. 92.1.14.8-92.1.14.10)

WESTERN AUSTRALIA RECORDS

There are literature reports for King's Sound, *Kimberley (Fletcher, 1898), Napier Broome Bay (Fry, 1914), Tompson's Spring Argyle Station, and Watjulum Mission (Copland, 1957).

According to Copland (1957), northwest Australia individuals are subspecifically different, and he names them *Hyla latopalmata watjulumensis*.

SOUTH AUSTRALIA RECORDS

Krefft (1870) mentions that *Litoria latopalmata* occurs at Adelaide. As Waite (1929) remarks, there is no other report of the occurrence of *Hyla latopalmata* in South Australia. I am ignoring this old report of Krefft.

COMMENTS

I have not seen any useful specimen of *Hyla latopalmata* from northwest Australia and cannot, therefore, say anything of importance about the status of Copland's (1957) new subspecies, *Hyla latopalmata watjulumensis*. Only one of the specimens that he includes in this subspecies is in the Australian Museum collection: No. 6011 from Napier Broome Bay. I listed it tentatively as *Hyla latopalmata* with the notation "too dried and shrivelled to be sure; possibly *nasuta*."

I am reasonably sure that *Pelodytes affinis* (Gray, 1842) from the north coast of New Holland (probably from Port Essington) is a synonym of *Hyla latopalmata*. Loveridge (1935) and Copland (1957) list *Hyla affinis* as a synonym of *Hyla lesueuri*. *Hyla affinis* is clearly a member of the *lesueuri* complex. I believe that it is not *Hyla lesueuri* itself but is *Hyla latopalmata*, as the following discussion shows.

The British Museum (Natural History) has two specimens in its collections labeled *Hyla affinis*. One of these (No. R.R.1936.12.3.192; 1947.2.2.81) is the type of *Pelodytes affinis*, and it is definitely stated on the label to be from Port Essington. The other (No. 67.5.6.85) is from Rockhampton. The type was measured with the following results:

body length, 33.7 mm.; tibia length, 19.0; head length, 11.7; head width, 11.7. Similar measurements for the Rockhampton specimen are: 33.1, 19.1, 11.7, and 11.8.

These two specimens were studied in relation to the characters given of table 6. Both are soft and considerably faded, but in all respects they agree with *Hyla latopalmata*, with the minor exception that the coloration of the posterior surface of the thigh of the type is more like that of *Hyla freycineti*. The tibia length/body length ratio for both individuals is 0.58. This is below the average but within the range for *Hyla latopalmata*.

The pertinent literature for *Hyla affinis* will be found in Gray (1842, description of *Pelodytes affinis*), Günther (1858, who listed it as a synonym of *Litoria freycineti*), Boulenger (1882, with a drawing of the adult), Aflalo (1896), Fletcher (1898), Lucas and Le Souëf (1909), Andersson (1913a), Nieden (1923, who proposed the new name *Hyla tornieri*, because *affinis* was preoccupied), Loveridge (1935, as a synonym of *Hyla lesueuri*), and Copland (1957, as a synonym of *Hyla lesueuri*).

Even though Gray was the first to describe, as *Pelodytes affinis*, the species now known as *Hyla latopalmata*, his name is preoccupied and not available. The earliest available name is *Litoria latopalmata* of Günther (1867), now *Hyla latopalmata*.

We cannot leave *Hyla latopalmata* without mentioning the strange case of *Hyla dimolops*, which has been thought by some to be a synonym of *Hyla latopalmata*. Duméril (1853) described a frog collected in New South Wales as *Litoria punctata*. In 1869 Cope pointed out that the name *punctata* was preoccupied, and he proposed a new name and, in addition, transferred the form to a different genus. The result was *Hyla dimolops*. Loveridge (1935) suggested that *Hyla dimolops* is a synonym of *Hyla latopalmata*, and in this view he is followed by Copland (1957). An examination of the type of *Litoria punctata* shows it to belong to the *Hyla aurea* group. It is discussed below in its proper place.

LITERATURE

Litoria latopalmata was described by Günther (1867) on the basis of two specimens from Port Denison. These syntypes are in the

British Museum (Natural History). Günther (1868a) and Krefft (1870) use the original name in mentioning the species. Boulenger (1882) and subsequent authors have referred to it as *Hyla latopalmata*.

General descriptions are given by Boulenger (1882, with a drawing of the adult), Lucas and Le Souëf (1909), Fry (1913a, with drawings of the adult and the foot), Nieden (1923, with Fry's drawing of the foot), Waite (1929, with Boulenger's drawing of the adult), Loveridge (1935; 1950, with a comparison to *Hyla kinghorni*), and Copland (1957, with the allocation of the specimens from northwest Australia to the new subspecies, *Hyla latopalmata watjulumensis*).

Geographic data are given by Krefft (1870, as *Litoria latopalmata*), Fletcher (1890, 1892, 1894b, and 1898), and Fry (1914).

A note on the habits is given by Harrison (1922).

Minor mention is made by Fletcher (1889), Aflalo (1896), and Andersson (1913a).

Slevin (1955) identified numerous individuals collected in Queensland as *Hyla latopalmata*. He remarks, however, that these do not differ in any constant way from *Hyla lesueuri*. There should be no difficulty in distinguishing between *Hyla lesueuri* and *Hyla latopalmata*, and, because Slevin was unable to do so, he may not have had examples of the two species. For this reason I have thought it best not to indicate his records on the map of distribution (fig. 64). He also refers to this species (p. 383) as *Hyla palmata*, a *lapsus calami*.

Reference should be made to the previous section for a discussion of *Pelodytes affinis*, *Hyla affinis*, and *Hyla tornieri*, which are probably synonyms of *Hyla latopalmata*.

Hyla freycineti (Tschudi)

FREYCINET'S FROG

Plate 46, figure 2; text figures 65, 66

DIAGNOSIS

A combination of the following characters separates *Hyla freycineti* from all other species in eastern New South Wales: very small discs on fingers and toes; first and second fingers of equal length; vomerine teeth between choanae; opposable thumb; no finger

webs; dorsal surface with numerous warts; no longitudinal skin folds; a pale triangular patch on snout with or without a dark center; and dorsal surface with irregular dark blotches.

This is a member of the *lesueuri*-group, and table 6 shows how the members of this group can be separated.

DESCRIPTION

In preserved specimens the dorsal surface is grayish brown, with large, irregular, dark brown blotches. Usually a triangular light area occupies the dorsal surface of the snout anterior to the eyes, and within this area there is usually a dark spot. A broad band, occupying most of the loreal region, extends from the snout to the eye. A light spot, just in front of the eye, nearly sunders the dark band. The dark band continues behind the eye and extends through the tympanic membrane to a point somewhat posterior to the arm. At the level of the arm the dark band is divided by a pale vertical bar. The tympanic membrane itself is frequently bordered by a thin white line. A pale line begins at the anteroventral side of the eye and extends posteriorly below the tympanic membrane to the arm. The edge of the upper and lower jaw is dark, with white spots.

Apart from the alternating dark and light areas of the lower jaw and an occasional individual with a dusky throat, the ventral surface is unpigmented.

The dorsal surface has numerous shallow warts that are circular or somewhat elongate. There is a chest fold. Anterior to this the skin is smooth, but the posterior portion is granular.

Hyla freycineti is a frog of moderate proportions, although, for a species of *Hyla*, its head is unusually narrow and pointed and the legs are long. The largest female (A.M.N.H. No. 63856) that I have seen has a body length of 49 mm., and the largest male (Australian Museum No. 4207) is 40 mm. The body proportion ratios of 10 individuals from eastern New South Wales in the collection of the Australian Museum and the American Museum of Natural History, which have body lengths of 36.0 to 49.0 mm., are: tibia length/body length, 0.64 ± 0.01 (0.61–0.65); head length/body length,

0.37 ± 0.00 (0.35–0.39); head length/head width, 0.94 ± 0.01 (0.90–1.01).

The following measurements in millimeters were made on the larger of the syntypes (No. 246 from Port Jackson in the Museum National d'Histoire Naturelle in Paris): body length, 45.8; tibia length, 26.3; head length, 16.4; head width, 14.5. The other syntype is a juvenile with a body length of 23.9 mm. Both are faded and soft. The larger specimen has a shorter tibia than other specimens of *Hyla freycineti* that I have seen. The fingers, outer metacarpal tubercle, and webbing of the fifth toe agree with the characters of *Hyla freycineti* shown in table 6. Nothing can be told about the pigment pattern, which is so important in the differentiation of the species of the *lesueuri* group. The smaller individual has warts on the back, a characteristic of *Hyla freycineti*. It would be difficult to be sure, on the basis of the syntypes alone, that the frog currently called *Hyla freycineti* is really that species. However, Duméril and Bibron (1841, pl. 88, fig. 2) provide a good illustration, presumably of the type, and this removes any doubt.

The tympanic membrane is very distinct. The skin above it forms a noticeable fold.

The fingers are long and slender (fig. 65). The sequence of lengths is $3 > 4 > 2 = 1$. The outer metacarpal tubercle is nicked. The male has a nuptial pad on the thumb.

The toes have moderately developed webs (fig. 65). The disc and one phalanx of the fifth toe and the disc and two phalanges of the fourth are free. There are a small inner metatarsal tubercle and a tiny outer one. A well-developed seam on the inner side of the foot extends from the ankle to the inner metatarsal tubercle.

The vomerine teeth are wholly between the choanae, with their anterior edge level with the anterior edge of the choanae (fig. 65).

HABITAT AND HABITS

I did not encounter this species.

Fletcher (1889) mentions that this species is active during the day and that it inhabits coastal swamps. Metamorphosing tadpoles were observed the middle of April. The mature tadpole was 35 mm., and the juvenile frogs 15 mm., in body length. Frogs, probably

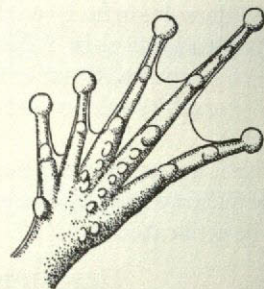
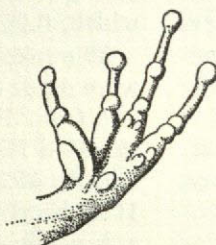
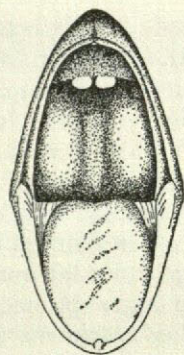


FIG. 65. *Hyla freycineti*. Open mouth, hand, and foot. A.M.N.H.
No. 23956. Sydney, New South Wales.

of this species, were observed breeding early in August.

Harrison (1922) observed an egg mass, possibly of this species, at Killara in January. It resembled the egg mass of *Hyla phyllochora*.

GEOGRAPHIC DISTRIBUTION

Hyla freycineti occurs along the coastal areas from the vicinity of Gladstone, Queensland, to Botany Bay in New South Wales (fig. 66). It has also been reported from the Blue Mountains. The type locality is "Nova Hollandia" in the original description of Tschudi ("1839" [1838]). The syntypes are from Port Jackson (=Sydney).

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

- *Far north coast (No. 12316)
- Huonbrook (No. 11862)
- Warrell Creek, Nambucca River (No. 4259)
- Woodford, Blue Mountains (No. 4349)
- Lindfield (Nos. 3974, 4187, 4332, 5687)
- French's Forest (No. 13421)
- Sydney (Nos. 7013, 7014, 7022, all old collection)
- Sydney, Paddington Reserve (No. 181)
- Maroubra Bay (No. 4207)
- Sydney, Botany (No. 5104)

The American Museum of Natural History has specimens from:

- Sydney, "Novara" Expedition (No. 23956)
- Maroubra Bay (Nos. 63856, 63857)

The British Museum (Natural History) has specimens from:

- Sydney (Nos. 64.7.6.5, 64.10.27.37, 64.10.27.38, 88.7.3.15, 88.7.3.16)

*Australia (No. 63.6.16.83)

*No locality (Nos. 64.10.24.34, 64.10.27.39)

QUEENSLAND RECORDS

Copland (1957) gives Warro, near Port Curtis, and the Buderim Mountains as localities. The Warro specimens are listed as in the Australian Museum collections, but I did not find them. Krefft (1867) records this species from Pine Mountains.

NORTHERN TERRITORY RECORDS

Fletcher (1898) mentions that the British Museum catalogue lists *Hyla freycineti* as occurring in the Northern Territory. This is in error, because, although Günther (1858) lists it, his "*Hyla freycineti*" is *Pelodytes affinis*, which is probably *Hyla latopalmata*. Boulenger (1882) does not list this species from the Northern Territory.

Krefft's (1870) record from Port Essington is based on Günther (1858), and is thus in error.

LITERATURE

Litoria freycineti was first described by Tschudi ("1839" [1838]) from Nova Hollandia. Shortly thereafter it was described with the same name by Duméril and Bibron (1841, with a colored illustration of the adult and foot). They mentioned it again in 1854. The syntypes are in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)]. Fitzinger (1843, 1861) proposed the name *Pelobius freycineti*.

Descriptions are given by Keferstein [1887, as *Hyla (Litoria) freycineti* with varieties *unicolor* and *verruculata*; 1868a, as *Hyla*

(*Litoria*) *freycineti* with the variety *verruculata* and a figure of the skull, and remarking that *unicolor* is really *Hyla lesueuri*], Steindachner ("1869" [1867], as *Litoria freycineti*), Boulenger (1882), Fry (1913a, with a figure of the foot), Nieden (1923, with Fry's figure of the foot), Loveridge (1935), and Copland (1957).

Fletcher (1889) and Harrison (1922) make brief reference to habits. Johnston (1912) describes the trematode parasites.

Geographic data are given by Krefft (1865, 1867) and Fletcher (1890, 1898).

There are minor mentions of the species by Gray (1841a), Fletcher (1894b, 1894c), Aflalo (1896), Lucas and Le Souëf (1909), and Andersson (1913a).

"*Litoria freycineti*" of Günther (1858) is actually *Hyla affinis*, which in turn is probably *Hyla latopalmata*.

Hyla (*Litoria*) *mystacina* was described by Keferstein (1867) from Australia. Boulenger (1882), Nieden (1923), and Copland (1957) lists it as a synonym of *Hyla freycineti*. Some points in the description make this allocation doubtful. The type, if extant, should be checked.

Hyla nasuta (Gray)

THE ROCKET FROG

Plate 45, figure 2; text figures 67, 68

DIAGNOSIS

Hyla nasuta can be distinguished from other frogs in eastern New South Wales by the following characteristics: no finger webs; first and second fingers approximately equal; anterior level of the vomerine teeth at the level of the anterior edge of the choanae; discs on fingers and toes vestigial; a broad, pale, longitudinal band, with or without dark spots in it, extending down the center of the back; outer metacarpal tubercle half split; head very narrow; and tibia very long.

Hyla nasuta is most likely to be confused with *Hyla freycineti*. In addition to its narrower head and longer tibia, it has definite horizontal stripes on the posterior side of the thigh (less definite stripes or a series of spots in *Hyla freycineti*), and the outer metacarpal tubercle is definitely split (only nicked in *Hyla freycineti*). Frequently, *Hyla nasuta* has longitudinal skin folds on the back in contrast

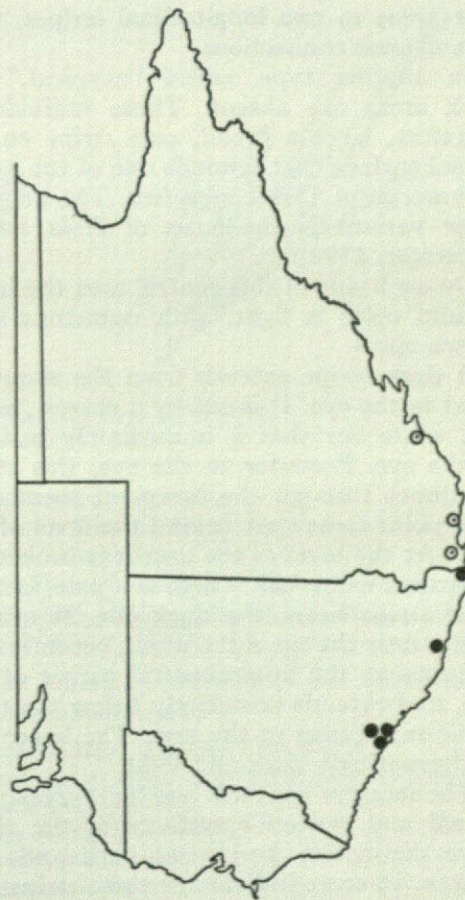


FIG. 66. *Hyla freycineti*. Geographic distribution.

to the circular warts of *Hyla freycineti*. Refer to table 6 for additional ways of distinguishing *Hyla nasuta* from the other species of the *lesueuri* group.

DESCRIPTION

This description is of preserved specimens. The most conspicuous feature in the coloration of *Hyla nasuta* is a light tan band that begins on the snout and extends to the hind end of the body. It includes the area between the eyes and then broadens slightly in the more posterior regions. In most individuals, which are here called "typical," there is a series of darker elongate spots or stripes in the center of this light area. These usually take the form of a single median stripe in the anterior region and of two stripes at the level of the urostyle. These dark areas restrict the

pale areas to two longitudinal stripes, with several cross connections.

In another type, called "atypical," the dark areas are absent. These individuals, therefore, have a broad, pale stripe on the dorsal surface that reminds one of the *affinis* polymorph of *Crinia signifera*. The atypical color variant is the basis of *Hyla semoni* (Boettger, 1894).

On each side of this central area the background color is light, with numerous dark brown spots.

A dark stripe extends from the snout almost to the eye. It is cut by a narrow, vertical, white bar that is immediately in front of the eye. Posterior to the eye, this stripe continues through the tympanic membrane to a point somewhat behind the level of the arm. At the level of the arm it is broken by a vertical white bar. There is a pale, lateral, head stripe below the dark one. It usually begins near the tip of the snout, becomes conspicuous at the anteroventral corner of the eye, and extends posteriorly below the tympanic membrane to the arm. The lower jaw is alternately dark and light.

The forearm has dark and light areas. The dorsal and posterior surfaces of the thigh have distinctive horizontal dark and pale stripes. In some individuals these stripes are irregular, consisting of contiguous spots. In others the stripes are more regular.

The ventral surface is without pigment except in the males, which have dusky throats.

The dorsal surface usually has numerous, narrow, longitudinal folds in the skin. A few individuals are nearly smooth. There is a chest fold. The abdomen is granular, and the rest of the ventral surface is smooth.

Of 56 specimens scored for the type of dorsal color pattern, 36 were typical, 14 were atypical, and six were intermediate. The atypical individuals are restricted to New Guinea and the northern part of Queensland and the Northern Territory. The typical individuals occur throughout the range of the species. Localities where both types occur are: Port Moresby and Kimila in New Guinea, Cape York in Queensland, and Groote Eylandt in the Northern Territory. The intermediates occur in Queensland, Murray Island, and Groote Eylandt. Presumably this is a case of polymorphism.

Hyla nasuta is a slender and long-legged frog. The largest individual that I have seen is a female from Kamili, New Guinea (British Museum No. 97.12.10.156), with a body length of 54.9 mm. The largest Australian individual has a body length of 49.1 mm. and is from Ravenshoe, Queensland (A.M.N.H. No. 19932). Measurements were made on 14 individuals from Australia and New Guinea in the Australian Museum and the British Museum (Natural History) that varied from 39.6 to 54.9 mm. in body length. The body proportion ratios for these are: tibia length/body length, 0.70 ± 0.00 (0.67–0.73); head length/body length, 0.37 ± 0.00 (0.35–0.41); head width/head length, 0.82 ± 0.00 (0.78–0.88).

The following measurements in millimeters were made on the type in the British Museum: body length, 46.6; tibia length, 32.5; head length, 16.8; head width, 13.7.

The tympanic membrane is very distinct. Frequently its rim is white. The skin above it forms a fold.

The fingers are not webbed (fig. 67). The sequence of finger lengths is $3 > 4 > 2 = 1$. The outer metacarpal tubercle is split for about half of its length. The discs are very small.

The toes have a moderately developed web. The disc and two phalanges of the fourth toe and the disc and one-half to nearly one phalanx of the fifth toe are free (fig. 67). The discs are very small. The inner metatarsal tubercle is very small. There is an outer one, but it is so small that it can usually not be seen without magnification.

The vomerine teeth are entirely between the choanae (fig. 67). Their anterior margins are level with the anterior margin of the choanae. The tongue is narrow.

HABITAT AND HABITS

I did not observe this species in nature.

Slevin (1955) found the adults in a "wide, shallow, and slow moving stream" where they were "floating among the patches of grass close to the bank."

GEOGRAPHIC DISTRIBUTION

Hyla nasuta occurs on the periphery of the continent from northern (possibly east-central) New South Wales to the Kimberleys

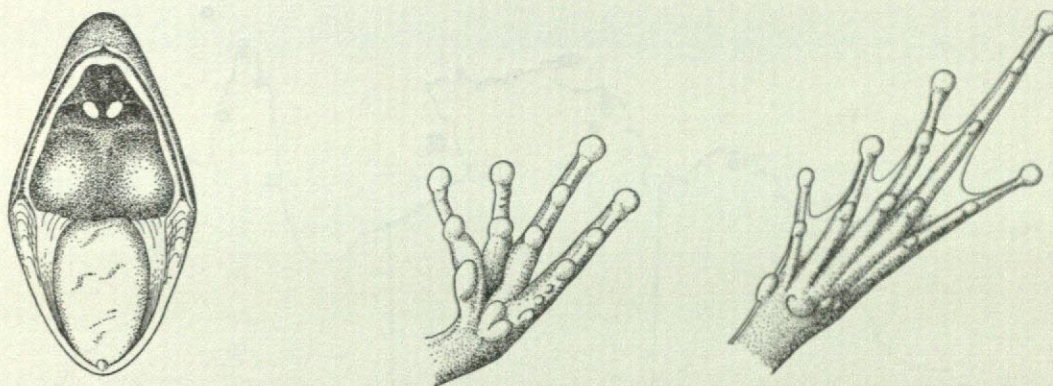


FIG. 67. *Hyla nasuta*. Open mouth, hand, and foot. A.M.N.H.
No. 63861. Groote Eylandt, Northern Territory.

(fig. 68). The type locality is Port Essington in the Northern Territory.

This species also occurs in southeast New Guinea.

NEW SOUTH WALES RECORDS

The Australian Museum has a specimen from:

Gurravambi, Nambucca River (No. 6321)

The British Museum (Natural History) has specimens from:

Clarence River (Nos. 64.7.6.2, 64.7.6.3)

Krefft (1863, 1865, 1867) records *Litoria nasuta* from Sydney and Randwick. Fletcher (1894b, 1894c) suggested that Krefft may have confused *Hyla freycineti* with this species. Such confusion is likely, because Krefft (1863) mentions the fact that he sent specimens from Sydney to the British Museum, but in that institution there are specimens of *Hyla freycineti* that he sent but no *Hyla nasuta*. I have not seen *Hyla nasuta* from the Sydney area, but Copland (1957) lists two individuals from Randwick Swamp in the National Museum (Melbourne) collection.

There are literature records for Whiteman Creek near Grafton, and Tooloom Falls near Urbenville (Copland, 1957).

QUEENSLAND RECORDS

The Australian Museum has specimens from:

*Moa Island, Torres Strait (No. 7960)

Mapoon, Gulf of Carpentaria (No. 3530)

Cape Bedford (No. 6952)

Cooktown (No. 1519)

25 miles inland from Cairns (No. 227)

*Cape York (Nos. 5010, 9590)

Warro, Port Curtis (Nos. 7017, 7019)

*Australia (No. 23969)

The American Museum of Natural History has specimens from:

Newcastle Bay, Somerset (No. 54226)

Lockerbie, 10 miles west southwest of Somerset (Nos. 54197, 54198)

Tozzer Range (No. 54264)

Speewak (No. 54193)

Ravenshoe district (No. 19932)

The British Museum (Natural History) has specimens from:

Murray Island (No. 85.6.30.70)

Near Cooktown (No. 1903.10.19.40)

*Cape York (Nos. 1930.10.11.4, 1930.10.11.5)

Port Mackay (Nos. 85.9.2.35-85.9.2.37)

Brisbane (No. 64.7.6.10)

*Australia (No. 51.2.12.22)

There are literature records for Yandina (Andersson, 1913a); Tambourine and Alice River on Cape York (Andersson, 1916); Kolonga Creek, 25 miles north of Gin Gin (Slevin, 1955); 25 miles southeast of Wowan, near Childers, and Shoal Bay near Rockhampton (Copland, 1957).

NORTHERN TERRITORY RECORDS

The Australian Museum has specimens from:

Night Cliff, Port Darwin (No. 10086)

Groote Eylandt (Nos. 9731, 9732, 13519, 13522, 13523, 13529-13531)

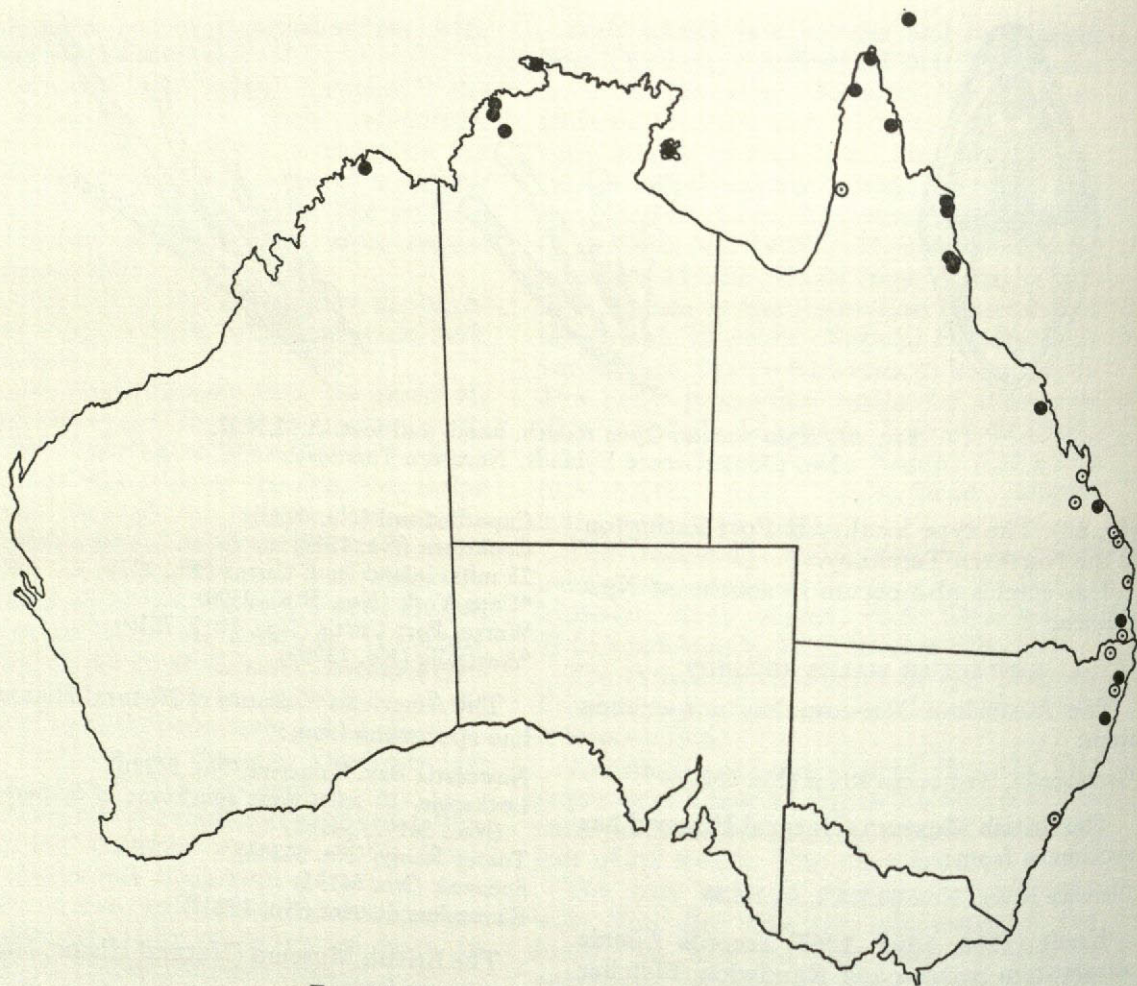


FIG. 68. *Hyla nasuta*. Geographic distribution.

The American Museum of Natural History has specimens from:

Koolpingah Station, 30 miles south of Darwin (No. 43834)
Groote Eylandt (Nos. 63860, 63861)

The British Museum (Natural History) has specimens from:

Port Essington (No. R.R.1947.2.22.81, the type; No. 44.5.13.35)
Adelaide River (No. 92.1.14.11)

Mitchell (1955) mentions three specific localities on Groote Eylandt where specimens were taken: Umba Kumba, Central Hill, and Old Mission.

WESTERN AUSTRALIA RECORDS

The Australian Museum has a specimen from:

Napier Broome Bay (No. 6010)

LITERATURE

This species was originally described as *Pelodytes nasuta* by Gray (1842). The type locality is Port Essington. The type is in the British Museum (Natural History).

Other descriptions are by Günther (1858, as *Litoria nasuta*), Keferstein [1868a, as *Hyla (Litoria) nasula*, a *lapsus calami*, with a figure of the adult], Steindachner ("1869" [1867]), as *Litoria nasuta*), Boulenger (1882), Lucas and Le Souëf (1909), van Kampen (1909, 1913, with a good illustration of the adult), Nieden (1923), Loveridge (1935, 1949), Slevin (1955, with a photograph of an adult), and Copland (1957).

The scapula is described by Procter (1921).

Papers that consist primarily of geographic data are by Krefft (1865, 1867, 1870, as *Litoria nasuta*), Günther (1867, as *Litoria nasuta*), Boettger (1892), Fletcher (1894b,

1898), Boulenger (1897), Roth (1908), Andersson (1913a, 1916), Fry (1914), Kinghorn (1931), and Mitchell (1955).

There are minor references to *Hyla nasuta* in Fletcher (1892, 1894c), Aflalo (1896), Werner (1901), van Kampen (1906), Fry (1912), and Noble (1931).

Hyla peninsulae was described by de Vis (1884b), with Cape York as the type locality. Boulenger (1885) suggested that it is a synonym of *Hyla nasuta*, and later authors have followed him.

Hyla semoni was described by Boettger (1894, with illustrations of the adult, head, and open mouth) from southeast New Guinea. Andersson (1913a) suggests that it is *Hyla nasuta*, which, on the basis of the description and illustrations, is very probable.

THE LESUEURI COMPLEX

Some general remarks are given here on the means of distinguishing the species of the *lesueuri* complex, on some unsolved problems, and on poorly known species.

The five species that are described above in detail, namely, *Hyla booroolongensis*, *Hyla lesueuri*, *Hyla latopalmata*, *Hyla freycineti*, and *Hyla nasuta*, have given difficulty in the past, but, so far as the New South Wales populations are concerned, they are fairly distinctive. The features that I have found most useful in separating them are summarized in table 6. The statements made in the table are necessarily brief, and some amplification is needed.

The modifications in the lateral black stripe that extends from the snout to the side of the body are extremely important for diagnosis. In table 6 four peculiarities of it are listed.

The portion of this stripe that is in front of the eyes is called the "anterior head stripe." It is best developed in *Hyla nasuta* and *Hyla freycineti*, in which it occupies most of the area between the canthus rostralis and an imaginary line parallel to the upper jaw and extending anteriorly from the ventral side of the eye. In these two species it usually reaches the tip of the snout. The anterior head stripe of *Hyla latopalmata* is wedge-shaped, being moderately broad just anterior to the eye but narrowing towards the nostril. The anterior terminus is usually at the nostril, but there may be a less definite continua-

tion that extends to the tip of the snout. In *Hyla lesueuri* the stripe is also short, as in *Hyla latopalmata*, but it is usually narrow throughout. Its width is about equal to the diameter of the nostril. It is narrowest midway between the eye and snout. In *Hyla booroolongensis* the stripe is absent or so indistinct as to be considered so.

In some species a white vertical bar immediately in front of the eye interrupts the anterior head stripe. In *Hyla nasuta* it is narrow, of equal width throughout, and usually cuts the anterior head stripe completely. In *Hyla freycineti* the bar is similar, except that it usually does not quite cut through the anterior head stripe. In *Hyla latopalmata* the bar is wedge-shaped, being broader at the ventral edge than above. In most individuals it does not cut through the anterior head stripe. Neither *Hyla lesueuri* nor *Hyla booroolongensis* possesses this vertical bar.

Some of the species have a prominent white or pale stripe below the eye. It is white and best developed in *Hyla nasuta*, in which it begins at the anteroventral corner of the eye and extends along the ventral side of the tympanic membrane to the arm. The portion behind the jaw articulation is on an elongate glandular fold. There may be an anterior extension to the nostril or tip of the snout, but, when present, it is relatively dark and inconspicuous. In *Hyla freycineti* the stripe below the eye is pale brown (in preserved specimens) instead of white. In extent it is similar to that of *Hyla nasuta*, except that almost invariably it has its anterior end at the level of the eye. In *Hyla latopalmata* this stripe is inconspicuous, as the entire ventral portion of the loreal region is pale. Frequently it does not extend more posteriorly than the tympanum. Neither *Hyla lesueuri* nor *Hyla booroolongensis* has a pale stripe below the eye.

Having considered the variations in the head stripes anterior to the eye, we should mention the variations, important in diagnosis, in the area behind the eye.

The dark lateral stripe continues behind the eye; in this area it is here referred to as the "posterior head stripe." In the five species it differs in length, breadth, and whether or not it is interrupted by a pale, vertical bar at the level of the arms. In *Hyla nasuta* and

Hyla freycineti the form of the posterior head stripe is the same. It is as wide as or slightly wider than the tympanic membrane. It extends posteriorly to a point about halfway between the arm and the leg, and in a few individuals it continues somewhat farther as a row of spots. In both species the posterior head stripe is divided by a conspicuous vertical bar at the level of the arms. This bar is usually wider in *Hyla freycineti* than in *Hyla nasuta*.

In *Hyla latopalmata* the posterior head stripe is as wide as the tympanum. It ends at the level of the arms so there can be no vertical bar, but in a few specimens it con-

tinues as a few small spots on the side.

Hyla lesueuri has a narrow posterior head stripe, the ventral edge of it being no lower than the middle of the tympanum. Posteriorly it extends at least to the level of the arms and then, in some individuals, continues to the groin as a line of spots.

The differences in dorsal skin texture, which are given in table 6, do not require additional comment.

The color pattern of the back and posterior surface of the thigh is useful in distinguishing the species, but it is subject to considerable variation. Table 6 should be used together with the descriptions for each species.

TABLE 6

CHARACTERISTICS OF NEW SOUTH WALES INDIVIDUALS OF THE SPECIES OF THE *Hyla lesueuri* GROUP

	<i>booroolongensis</i>	<i>lesueuri</i>	<i>latopalmata</i>	<i>freycineti</i>	<i>nasuta</i>
Snout shape	Most rounded	Rounded	Slightly pointed	Less pointed than in <i>nasuta</i>	Most pointed
Head width/head length (mean and range)	1.08 (1.02-1.11)	1.05 (1.02-1.09)	0.98 (0.89-1.11)	0.94 (0.90-1.01)	0.82 (0.78-0.88)
Tibia length/body length (mean and range)	0.55 (0.53-0.59)	0.63 (0.60-0.65)	0.63 (0.57-0.70)	0.64 (0.61-0.65)	0.70 (0.67-0.73)
Anterior head stripe	Absent	Narrow; full length	Narrow; wedge-shaped; usually short	Broad; full length	Broad; full length
White bar before eye	Absent	Absent	Broad; usually not cutting anterior head stripe	Narrow; not quite cutting anterior head stripe	Narrow; cutting anterior head stripe
Pale stripe below eye	Absent	Absent	Not extensive; inconspicuous	From eye to arm; conspicuous	From eye (or snout) to arm; conspicuous
Posterior head stripe	Absent	Half width of tympanum	Width of tympanum; ends at arms	Width of tympanum; ending between arm and leg	As in <i>freycineti</i>
Vertical bar in posterior head stripe	Absent	Absent	Absent	Conspicuous	Conspicuous
Texture of back	Smooth	Smooth	Smooth	Usually oval or elongate warts	Usually many narrow longitudinal ridges
Color of back	Inconspicuous mottling; dark	Nearly uniform; usually dark	Pale; with or without dark mottling	Blotches or irregular dark and light stripes	Wide pale band or longitudinal dark and light stripes
Posterior surface of thigh	Dark, with small pale spots	Black, with pale spots	Dark reticulum on light background	Large pale spots in horizontal rows on dark background	Horizontal dark and light stripes
Finger length	$2 > 1$	$2 \geq 1$	$1 > 2$	$1 = 2$	$1 \geq 2$
Outer metacarpal tubercle	Nearly half split	Variable	Entire	Nicked	Half split
Amount of fifth toe free of web	Disc	Disc and $\frac{1}{4}$ to 1 phalanx	Disc and $\frac{1}{2}$ phalanx or less	Disc and 1 phalanx	Disc and $\frac{1}{2}$ to 1 phalanx

The second finger is always short in these five species, but there are minute differences of diagnostic importance. When the hand is closed, it is found that *Hyla freycineti* and nearly all individuals of *Hyla nasuta* and *Hyla lesueuri* have the first and second fingers of equal length. In a few individuals of *Hyla nasuta* (including the type) and all individuals of *Hyla latopalmata*, the first finger is a little longer than the second. In *Hyla booroolongensis*, and in some specimens of *Hyla lesueuri* the second finger is very slightly longer than the first.

The form of the outer metacarpal tubercle and the extent of the toe webs are characteristics that can be used only in living or well-preserved individuals.

The five species listed in table 6 are markedly different. Other species appear to belong to the *lesueuri* complex and present problems of one sort or another regarding their status. Three are from New South Wales and are here discussed.

Hyla kinghorni was described by Loveridge (1950) from a single specimen collected by J. R. Slevin at Ulong, New South Wales. Copland (1957) has redescribed the type specimen and discussed the affinities of this species. Both Loveridge and Copland believe that *Hyla kinghorni* is closely related to *Hyla latopalmata*. Slevin (1955) mentions the species, which is known only from the type.

I examined the type and have nothing to add to the descriptions of Loveridge and Copland. In appearance *Hyla kinghorni* is somewhat intermediate between *Hyla lesueuri* and *Hyla latopalmata*. A photograph of the type is given in plate 46, figure 4. I have considerable doubts of the validity of this species. Perhaps it is a hybrid between *Hyla lesueuri* and *Hyla latopalmata*, but the suggestion is made without my knowing whether or not these species can be crossed.

Hyla jenolanensis was described by Copland (1957). Here again the species is represented by a single individual collected in 1954 from a creek bed near Bottomless Pit, Jenolan Caves, New South Wales. This specimen was received by the Australian Museum after I had studied its collections, so I cannot add any information to that given by the describer. Copland places his new species in the *lesueuri* group, but it is difficult to under-

stand why. In the description of the species, reference is made to what is apparently a well-developed finger web: "the extremities have become dried but the extent of webbing between the fingers is about 27, 40 and 32%." (There is some confusion here. In his key to the species, *Hyla jenolanensis* is listed under section "EE . . . fingers free of web.") The only other species of New South Wales *Hyla* that have so much finger webbing are *Hyla caerulea*, *Hyla chloris*, *Hyla gracilentia*, *Hyla peroni*, and *Hyla dentata*. The species of the *lesueuri* complex do not have finger webs.

Hyla jenolanensis is a large species, having a body length of 62 mm. This puts it above the range of all species of the *lesueuri* complex except *Hyla lesueuri* itself. Other hylas of New South Wales that reach this size are *Hyla caerulea*, *Hyla chloris*, *Hyla peroni*, *Hyla citropa*, and *Hyla jervisiensis*.

On the basis of measurements given by Copland, the tibia length/body length ratio is quite low, namely, 0.47. This would exclude it from all members of the *lesueuri* complex (see table 6).

In many respects the description of *Hyla jenolanensis* reminds me of *Hyla peroni*.

A third puzzler from eastern New South Wales is *Litoria copei* described by Steindachner ("1869" [1867], with illustrations of the adult, mouth, hand, and foot). The type, and only, specimen is a beautiful female from New South Wales (probably Sydney) that was captured by the "Novara" expedition. Boulenger (1882) believed it, somewhat uncertainly to be sure, to be a synonym of *Hyla lesueuri*, and later authors, such as Nieden (1923) and Copland (1957), have followed him. In some respects, but not in others, Steindachner's description would seem to apply to *Hyla lesueuri*. It is not too important to decide what *Litoria copei* is a synonym of, because no species of the *lesueuri* group from the Sydney area is without a name, and all the species have names antedating 1869. Nevertheless, it would be good to have the matter settled by an examination of the type. *Litoria copei* is also referred to by Keferstein [1868a, as *Hyla (Litoria?) copei*] and Günther (1868b), who suggested that it might be *Litoria wilcoxii*, now a synonym of *Hyla lesueuri*.

The final and most confusing problems con-

cern the status of some Queensland specimens. I have no solution for these problems but wish to suggest that some of the older names may have been made synonyms prematurely. I was first aware of the complexity of the problem when collecting at Binna Burra in southern Queensland. Three females of a striking species were taken. One is shown in plate 45, figure 5. It is similar to *Hyla lesueuri*, but differs in several respects from individuals of this species found in the Sydney area. The skin of the back is smoother, the coloration is more vivid, the leg is longer (tibia/body ratios, 0.67–0.68), and the head is narrower (head width/head length ratios 0.94–0.97). No typical specimen of *Hyla lesueuri* was collected at this locality.

The differences between the Binna Burra and Sydney individuals, which are shown side by side in plate 45, are considerable. Differences of this magnitude can occur as intraspecific variation, but in the present case this seems unlikely, because I have seen examples of *Hyla lesueuri* that are closely similar to those from Sydney, from as far north as Ravenshoe in Queensland.

I am not the first to have noticed these *lesueuri*-like individuals in southern Queensland. Lamb (1911) described *Hyla vinosa* from Ithaca Creek, Brisbane. The type specimen was redescribed by Fry (1915, with an illustration of the adult, roof of the mouth, vomerine teeth, hand, and foot). My Binna Burra individuals seem to check with Fry's description, except that the toe webs are slightly less extensive. Fry says: "In the original description this frog was compared to *Hyla nigrofrenata*, Gthr., but its affinities are more with *H. lesueurii* than that species. I am inclined to regard the differences as too slight to allow its specific distinction from the latter. Nevertheless, it is a good geographical race, although it does not wholly replace *H. lesueurii* in the northern state. I have recently received from Dr. T. L. Bancroft several specimens of *H. lesueurii* which resemble the typical form, i.e., that found round Sydney, New South Wales. These were collected at Eidsvold, Burnett River, Queensland. Northern Queensland examples of var. *vinosa* are larger than any specimens of the typical form that I have seen, and they also possess relatively much larger discs. If with additional

material these characters are proved quite stable, it may then be necessary to raise this form to specific rank." After this passage was written, he examined the type and added the following comment (p. 106): "*Hyla vinosa*, Lamb, is a varietal form of *H. lesueuri*, D. & B., and should designate Queensland examples of this species."

The fact that typical *Hyla lesueuri* and *Hyla vinosa* do not replace each other but apparently overlap is of far greater significance today in the determination of relationships than it would have been in Fry's time.

With the above facts, I would feel nearly sure that two species were involved, but additional evidence makes this view uncertain. I have seen specimens from Tooloom Falls, near Urbenville, New South Wales (A.M.N.H. Nos. 64139–64141), and the Blue Hole, Gara River, near Armidale, New South Wales (A.M.N.H. No. 64835), that are somewhat intermediate between the typical *Hyla lesueuri* and the Binna Burra individuals.

I cannot solve this problem with the material at hand. There may be two species, *Hyla lesueuri* and *Hyla vinosa*, in southern Queensland and possibly northern New South Wales. A word of caution should be interjected. I have not seen the type specimen of *Hyla vinosa*, and my suggestion that the Binna Burra individuals are conspecific with it is based solely on Lamb's and Fry's descriptions. Thus, even if the Binna Burra individuals are not *Hyla lesueuri*, they also may not be *Hyla vinosa*.

Additional references to *Hyla vinosa* as a synonym of *Hyla lesueuri* will be found in Fry (1912), Nieden (1923), Loveridge (1935), Slevin (1955), and Copland (1957).

A second problem involving a Queensland member of the *lesueuri* complex concerns the status of *Hyla nigrofrenata*, which was described by Günther (1867). The type locality is Cape York. The species was recognized by Boulenger (1882) who had only the two syntypes. Loveridge (1935) and Copland (1957) list it as a synonym of *Hyla lesueuri*.

The British Museum (Natural History) now has four specimens that are identified as *Hyla nigrofrenata*. Two are the syntypes (Nos. 67.5.6.94, reregistered as 1947.2.23.47, and 67.5.13.28, reregistered as 1947.2.23.46) from Cape York. Another is from Alexandra,

Northern Territory (No. 1906.3.31.82), and the fourth is from Port Darwin (No. 90.12.2.24).

The dimensions in millimeters of No. 1947.2.23.47 are: body length, 35.8; tibia length, 24.9; head length, 12.6; head width, 12.1. For No. 1947.2.23.46 the similar measurements are: 41.2, 27.6, 14.9, and 13.7.

I studied the types in relation to the characteristics in table 6. They resemble *Hyla latopalmata* in head shape, in the condition of the pale stripe below the eye, in the form of the outer metacarpal tubercle, and in the fact that the first finger is definitely longer than the second. The anterior head stripe is broad, as in *Hyla nasuta* and *Hyla freycineti*. The white bar before the eye is as in *Hyla nasuta*. With respect to the posterior head stripe and the vertical bar in the posterior head stripe, they are like *Hyla nasuta* and *Hyla freycineti*. The back is smooth and without any pattern. The pattern of the posterior surface of the thighs is irregular but tends to be horizontal as in *Hyla freycineti*.

When I studied the frogs in the Australian Museum there were specimens listed as *Hyla nigrofrenata* from Moa Island, Torres Strait (No. 7958); Somerset, Cape York (Nos. 4527, 4528); Cape York (No. 5009); upper Endeavour River, Queensland (No. 7591); Bloomfield River, Cooktown, Queensland (No. 2284); Yam Creek, 100 miles inland from Port Darwin (Nos. A4914, 4916, 4918, 4921, 4925, 4926); and Groote Eylandt (Nos. 9728-9730, 9733-9735). In all of these the first finger was longer than the second. In this respect, as well as in others they seemed somewhat like *Hyla latopalmata*, but I doubt if they are that species. Copland (1957) lists them as *Hyla lesueuri*, but they are not *Hyla lesueuri* as I understand it.

These British Museum and Australian Museum *Hyla nigrofrenata* are most puzzling. They do not conform to any of the five species on the basis of the characters listed in table 6. They have a confusing association of the specific features of *Hyla nasuta*, *Hyla latopalmata*, *Hyla freycineti*, and *Hyla lesueuri*. *Hyla nigrofrenata* may be a valid species, and it should not be synonymized until the entire *lesueuri* complex of northern Australia can be adequately sampled and studied.

Additional references to *Hyla nigrofrenata*

are by Aflalo (1896), Andersson (1913a, 1916), Günther (1868a), Kinghorn (1931), Lucas and Le Souëf (1909), Mitchell (1955), and Nieden (1923).

Hyla aurea (Lesson)

THE GREEN AND GOLDEN BELL FROG

Plate 46, figure 1; text figures 69, 70

DIAGNOSIS

Hyla aurea can be distinguished from other frogs in eastern New South Wales by the following characteristics: back green, with brown spots; dorsolateral fold yellow; thumb opposable; fingers and toes with small discs; and second finger longer than first.

DESCRIPTION

Hyla aurea shows considerable geographic variation, and the following description applies to individuals from the coastal area of New South Wales.

The upper parts are green, with prominent and irregular brown spots. A yellow dorsolateral fold extends from the eye nearly to the groin. Another yellowish line begins below the eye, passes below the tympanic membrane, and terminates at the level of the arm. There is a dark line below the canthus between the nostril and eye. The groin and posterior surface of the thigh are blue-green.

The under parts are white except for the throat of the male, which has a yellowish wash.

The skin of the back is smooth. The sides, ventral to the dorsolateral fold, are very granular. The abdomen and ventral surface of the thighs are also very granular. The throat is smooth. There is a prominent chest fold.

This is a large species that is *Rana*-like in body form. The body proportion ratios for 14 individuals from Sydney, Burradoo, Bodalla, and Eden, which vary in body length from 55.1 to 77.8 mm., are: tibia length/body length, 0.50 ± 0.01 (0.46-0.53); head length/body length, 0.34 ± 0.00 (0.32-0.36); head width/head length, 0.92 ± 0.01 (0.89-0.94). The largest individual of the eastern New South Wales variety that I collected has a body length of 77.8 mm. (Burradoo, A.M.N.H. No. 64843). The western variety, *raniformis*, is much larger. A female (A.M.N.H. No.

64875) from Delegate, New South Wales, has a body length of 93.9 mm.; and a male (A.M.N.H. No. 64879) from the same locality, one of 91.8 mm.

The tympanic membrane is prominent and golden in color. In most species of *Hyla* the posterior edge of the tympanum is at the level of the articulation of the jaw. In *Hyla aurea*, however, it is not quite so far back.

The fingers are not webbed (fig. 69). The length sequence is that usual for *Hyla*, namely, $3 > 4 > 2 > 1$. The discs are only slightly wider than the rest of the fingers. The thumb of the breeding male has an extensive nuptial pad. The thumb is opposable.

The toes have a strong, fleshy web (fig. 69). The fifth toe is webbed nearly to the disc, and the fourth toe has the disc and one, or a little more than one, phalanx free. There is a small inner metatarsal tubercle. A tarsal fold extends from the heel to the tip of the first toe.

The tongue is broad and has a posterior nick (fig. 69). The anterior edge of the vomerine teeth is generally at the level of the anterior edge of the choanae. They are largely between the choanae but, in some individuals, the teeth are so large that their posterior edge is behind the level of the choanae.

GEOGRAPHIC VARIATION

H. W. Parker (1938) recognized three forms of the *Hyla aurea* type. *Hyla aurea aurea*, which is shown in plate 46, figure 1, is characterized by a short, inner metatarsal tubercle, a pale-colored and continuous dorsolateral fold, smooth back, no middorsal light line, and a light line from beneath the eye to shoulder. He had specimens from a single locality in Australia, namely, Nowra in New South Wales.

His second form, *Hyla aurea raniformis*,

which is shown in plate 46, figures 3 and 5, is characterized by a short, inner metatarsal tubercle, a discontinuous dorsolateral fold, warts on the back, and a middorsal light line. His specimens were from Tasmania, Victoria, Western Australia, and the Northern Territory.

Finally, *Hyla cyclorhynchus* from Western Australia is characterized by a longer inner metatarsal tubercle, a discontinuous and indistinct dorsolateral fold, warty back, usually no middorsal line, and prominent yellow spots on the concealed surfaces. Parker thought it probable that *Hyla cyclorhynchus* is a distinct species and not merely a subspecies of *Hyla aurea*. In this belief he is followed by Main (1954a). I think they are correct.

The relation of *Hyla aurea aurea* and *Hyla aurea raniformis* is interesting but by no means settled. Parker did not have sufficient material to decide whether intergradation occurs or not, and, if so, where. The material in the Australian Museum and the American Museum of Natural History, however, throws considerable light on this problem.

The *aurea* type occurs only in eastern New South Wales (fig. 70), where its presence is shown on the map by large dots. In southeastern and southern New South Wales the *raniformis* type occurs (shown by the circles with central dots). In addition, a single individual from the Armidale region is of this type. Its occurrence in this part of the state is surprising. This individual has the median dorsal stripe, warty back, white spots on the hind portion of the thigh (not found in all *raniformis*), and extensive toe webbing characteristic of the *raniformis* type.

There are some individuals that are possibly intermediate between the *aurea* and *raniformis* types. These occur in southern

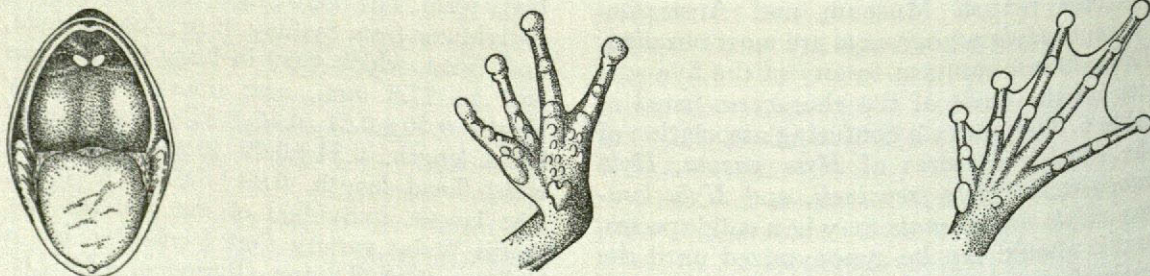


FIG. 69. *Hyla aurea aurea*. Open mouth, hand, and foot. A.M.N.H. No. 64856. Eden, New South Wales.

New South Wales and in eastern South Australia. I am not sure that these represent intergrades; possibly they are somewhat atypical *raniformis*.

In Victoria, Tasmania, and Western Australia only the *raniformis* type occurs.

The localities for *Hyla cyclorhynchus* are shown on the map as plus symbols (+). Its relation to the *raniformis* type is interesting. The two meet at about the north-south line connecting Albany and Tambellup. Both types are in collections from King George's Sound and Tambellup. There are also individuals from these places that may be intergrades.

No doubt it will be noticed that I have not used a name for the *aurea* type or the *raniformis* type so far in the present discussion. When one crosses the *aurea* type from eastern New South Wales with the *raniformis* type from Western Australia, the hybrids die as haploid embryos (Moore, 1954a), which indicates that the eastern *aurea* type and the western *raniformis* type are different species. Unfortunately, no crosses have been made between the western *raniformis* type and the eastern *raniformis* type or between the eastern *raniformis* type and the *aurea* type. Until these crosses have been made, and until there are field data for the behavior of the eastern *raniformis* type and the *aurea* type in areas where they both occur, any taxonomic solution must be tentative.

Copland (1957) has proposed a solution that, except for the Tasmanian populations, I am adopting until the necessary data are available. The eastern New South Wales *aurea* type is designated *Hyla aurea aurea*. The eastern *raniformis* type is designated *Hyla aurea raniformis*. The *raniformis* type of Western Australia is given a new name, *Hyla moorei* (pl. 46, fig. 5). I might add, however, that I suspect *Hyla aurea raniformis* is actually a valid species, not a subspecies.

Copland gives a new name for the Tasmania frogs, *Hyla aurea major*. This I cannot accept. He writes: "the Tasmanian race is separated from *raniformis* almost solely on the grounds of larger size. Four Q.V.M. [Queen Victoria Museum] specimens measured 72, 62, 61 and 54 mm. Lord and Scott (1924: 102) give the body length as 80 mm. In large series of *raniformis* 60 mm. was only

exceeded in about 60% of specimens, and 70 mm. only once (about 1%), and then only by 1 mm. (71 mm.). It must be noticed, however, that Keferstein gave the body length of his type of *raniformis* at 82 mm., which can only be regarded as very exceptional."

Unless one restricts his material to breeding adults, it is dangerous to use size as a criterion. The largest Tasmania individual that Copland reported is 72 mm. Two of seven adults from East Lakes, Sydney, a single adult from Burradoo, and one of three adults from Eden (all New South Wales) that I collected are larger than 72 mm. Furthermore, seven out of eight collected at Delegate, New South Wales, are 72 mm. or larger. The two largest are 92 and 94 mm.

HABITAT

Hyla aurea is an aquatic species reminding me of the American *Rana clamitans*. I found it in ponds (pl. 29, fig. 1), lakes, streams (pl. 28, figs. 1, 2), and grassy marshes.

VOICES

The call is a guttural, slow, "wr-a-a-a-ck, wr-a-a-a-ck." The frogs call during the day as well as at night.

Harrison (1922) writes: "... the breeding chorus consists of four notes, the first long drawn out, the second somewhat shorter, and the last two quite short—'craw-awk, crawk, crok, crok.' Each note is uttered during inflation of the vocal sac, no sound issuing during deflation, so that four separate inflations occur."

Kreff (1870) says the "voice of the male is very loud, and when pinched they scream almost like a child."

McCoy (1881) notes the similarity of the call to that described by Aristophanes for Greek frogs.

BREEDING HABITS

Fletcher (1889) says that "this species breeds from about the middle of spring through the summer." He mentioned specifically October 20 and the first week of December. Metamorphosing individuals were seen in December, March, and April.

Harrison (1922) found *Hyla aurea* breeding in January at Thirroul, New South Wales. The ova were submerged (but he believes

they may also float). The diameter of the egg is 1.4 mm. and that of the surrounding jelly 2 mm. He observed a clasping pair that consisted of a male *Hyla peroni* and a male *Hyla aurea*.

EMBRYONIC DEVELOPMENT

A single group of *Hyla aurea* embryos was studied. The female, which was collected at Burradoo, New South Wales, on September 16, 1952, was injected with pituitary glands of *Bufo marinus* to stimulate ovulation. Sperm were obtained from two males collected at East Lakes, New South Wales, and the ova were fertilized artificially.

The diameter of the ova averages 1.4 mm. The jelly is highly fluid, reminding one of that of *Rana clamitans* or *Rana catesbeiana*. At uncontrolled temperatures, which did not vary much from 20° C., the times from first cleavage to various stages are as follows: stage 10, 19 hours; stage 12, 24 hours; stage 16, 48 hours; stage 18, 66 hours; and stage 20, 92 hours.

Development follows the typical *Rana* pattern, including the formation of external gills, and need not be described. The anus of the tadpole opens on the right side of the tail fin. The spiracle is on the left and rather far ventrad. There are two rows of teeth in front of the mouth, the more anterior may be interrupted; and three rows behind the mouth, the first usually being interrupted.

GEOGRAPHIC DISTRIBUTION

Hyla aurea is found in New South Wales from the Queensland border to Victoria and west in the Riverina district and lower Murray Valley (fig. 70). It occurs in Victoria, Tasmania, and eastern South Australia. It is also reported from the Northern Territory. The type locality is the Macquarie River at Bathurst. In Western Australia there is a sibling species, *Hyla moorei*.

In the following lists the specimens are identified as the *aurea* type and the *raniformis* type. The first would be *Hyla aurea aurea* according to Copland's classification. If we do not recognize his subspecies, *Hyla aurea major*, all the eastern frogs of the *raniformis* type are *Hyla aurea raniformis* and the western ones of the *raniformis* type are *Hyla moorei*.

These frogs have been introduced in several places. The Australian Museum has specimens of the *raniformis* type from Noumea, New Caledonia (No. 6664), and the Botanical Garden, Rotorua, New Zealand (No. 12075). The British Museum (Natural History) has specimens of the *aurea* type from Noumea, New Caledonia (Nos. 83.3.11.25, 1926.9.17.2, 1926.9.17.3), and one of the *raniformis* type from China (No. 44.4.31). The last locality is probably the one to which Boulenger (1882) added three "question marks."

NEW SOUTH WALES RECORDS

The Australian Museum has specimens from:

aurea Type

Lower Clarence River (No. 7527)
Gurravambi, Nambucca River (No. 6324)
Warrell Creek, Nambucca River (No. 4251)
Nambucca River (Nos. 5893, 5894)
Capertee (No. 7325)
Upper Colo, via [near] Richmond (No. 7974)
Maroubra (Nos. 4194-4206)
Sydney (Nos. 5388, 5389, 8454, 8456, 8483, 9558)
Wentworthville (Nos. 9424, 9426, 9427)
Cook's River, near Sydney (No. 5849)
Botany Bay (Nos. 4452, 8256, 9532)
Woonoona, near Bulli (Nos. 4665-4668)
Burrawang (No. 7376)
Tumut (No. 9644)
Pambula (Nos. 7446, 7447)

Possible *aurea-raniformis* Intergrades

Koonaden, Leeton (Nos. 9482-9484)
Emu Plains, Urana, 18 miles from Murrumbidgee at Narrandera (No. 7344)
Berridale, Monaro (No. 5233)

raniformis Type

Yanco (Nos. 10661-10668, 10689)
Tubbo Station, Riverina (Nos. 10669-10683, 10687, 10688)
Mt. Horeb, Tumut District (No. 8421)

The American Museum of Natural History has specimens from:

aurea Type

"Balladelah," possibly Bulahdelah (Nos. 12948, 12949)
Sydney (Nos. 3821, 3822, 6672)
East Lakes, Sydney (Nos. 64844-64851)
Burradoo (No. 64843)



FIG. 70. *Hyla aurea* and allied forms. Geographic distribution. The symbols have a different meaning from those used on other maps. The solid spots are for *Hyla aurea aurea*. The half-solid spots show possible intermediates between the *aurea* type and the *raniformis* type. The circles with a central dot are for the *raniformis* type of individuals. According to Copland (1957), those in the east and in the Northern Territory are *Hyla aurea raniformis* and those in the southwest are *Hyla moorei*. The X in northeast New South Wales shows the type locality of *Hyla aurea ulongae*. The + signs in Western Australia are localities for *Hyla cyclorhynchus*. The small circles are literature records, which can be assumed to apply to the form occurring in the area.

Bodalla (Nos. 64857–64861)

Eden (Nos. 64852–64856)

*Australia (No. 23971)

raniformis Type

Booroolong Creek, 20 miles northwest of Armidale
(No. 64882)

Albury (Nos. 64864–64873)

Delegate (Nos. 64874–64881)

The British Museum (Natural History)
has specimens of the *aurea*-type from:

Nowra (Nos. 1932.3.5.1–1932.3.5.6, 1933.9.4.1–
1933.9.4.5)

*New Holland (No. 45.5.25.22; poorly preserved;
collected by C. Darwin, no less; not sure of
type)

There are literature records for Yass (Flet-

cher, 1892), Jervis Bay (Fletcher, 1894b), Razorback Mountain near Picton, Tallong, Tocumwal, Gol Gol, Balranald, and Adamina (Copland, 1957).

AUSTRALIAN CAPITAL TERRITORY

The American Museum of Natural History has specimens of the *raniformis* type from: Canberra (Nos. 64299, 64300)

VICTORIA RECORDS

The American Museum of Natural History has specimens of the *raniformis* type from:

Gunbower (No. 64863)
Melbourne (Nos. 50230-50234)
Healesville (No. 64862)

The British Museum (Natural History) has specimens of the *raniformis* type from:

Melbourne (Nos. 58.9.13.1, 80.1.3.4)
Yarra River (No. 96.6.17.17; possibly intermediate with *aurea* type)

There are literature records for Millgrove (Loveridge, 1935), 18 miles west of Bairnsdale, 13 miles southeast of Horsham, Bacchus Marsh, Mordialloc, Brighton, Cobungra, and Macedon (Copland, 1957). Lucas (1892) says that it is common "in all parts of the colony."

TASMANIA RECORDS

The Australian Museum has a specimen of the *raniformis* type from:

Launceston (No. 6048)

The British Museum has specimens of the *raniformis* type from:

Near Launceston (Nos. 1901.9.13.50-1901.9.13.54)
*Tasmania (Nos. 45.5.2.27, 45.5.28.38)
*New Holland (No. 38.3.10.6)
*Van Dieman's Land (Nos. R.R.1936.12.3.152-1936.12.3.156; all juveniles, poorly preserved, unsure of type)

There are literature reports for Stanley (Loveridge, 1934), Davenport (English, 1910), "Burine" (possibly Burnie; Fletcher, 1898) and *Collins Gap (Copland, 1957).

All these records are for the north coast.

SOUTH AUSTRALIA RECORDS

The Australian Museum has specimens from:

Narracoorte (Nos. 5959-5962, 6683)

Three of these are of the *raniformis* type, and two are possibly intermediates between the *aurea* type and the *raniformis* type.

Copland (1957) reports it from Taillem Bend.

WESTERN AUSTRALIA RECORDS

According to Copland (1957), all the frogs of *raniformis* type from Western Australia are *Hyla moorei*.

The Australian Museum has specimens, all of the *raniformis* type, from:

Perth (Nos. 2347-2357, 7576, 7578-7583)
Newcastle (No. 7531)
Donnybrook (No. 7476)
Tambellup (Nos. 9888, 9889)
Tudor, 27 miles from Albany (No. 7696)
Albany, King George's Sound (Nos. 5297-5300, 7698, 7699, 7703, 7743-7745, and old collection Nos. 7132, 7133, 7144, 7146, 7157, 7187)
No specific locality (Nos. 4953, 4954, 10463, and old collection No. 7137)

Number 7146 from King George's Sound, and possibly Nos. 9888 and 9889 from Tambellup, approach *Hyla cyclorhynchus*. The Australian Museum has typical *Hyla cyclorhynchus* from:

Tambellup (No. 11537)
King George's Sound (Nos. 7183, 7184, 7186 from the old collection)
West Australia (Nos. 7045-7047, 7159-7166, 7168-7170, all old collection)
Mondrain Island, Recherche Archipelago (No. 7736)
Lucky Bay, east of Recherche Archipelago (No. 7737)

Thus typical *Hyla cyclorhynchus*, the *raniformis* type, and possibly intergrades between them occur at Tambellup and King George's Sound.

The American Museum of Natural History has specimens of the *raniformis* type from:

Attadale (Nos. 64883-64885)
Pemberton (Nos. 64886-64892)

It also has one of the syntypes of *Hyla cyclorhynchus* (No. 62493) from "West Australia."

The British Museum (Natural History) has specimens, all of the *raniformis* type, from:

Swan River (Nos. 58.11.25.84, 58.11.25.85, 64.10.6.8, 63.11.12.44, 44.6.13.147)
King George's Sound (Nos. 64.10.27.21, 55.10.16.2)

*King River (Nos. 1906.11.1.11, 1906.11.1.12)
 *"West Australia" (Nos. R.R.1936.12.3.142-1936.12.3.151)

The collection also contains specimens of *Hyla cyclorhynchus* from:

Toolbrunup (Nos. 1931.7.1.73-1931.7.1.77)
 Baldwin's Lake north of Mt. Toolbrunup (No. 1931.7.1.72)
 Scaddan, north of Esperance (No. 1940.3.24.1)
 Scaddan (Nos. 1948.1.2.45-1948.1.2.68)
 *"West Australia" (Nos. 69.7.22.3-69.7.22.7; syntypes of *Hyla aurea cyclorhynchus*)

There are literature records for *Hyla moorei*, under the name *Hyla aurea*, from Jarrahdale, Pinjarra, Bunbury, Busselton (Werner, 1914), and Nangabrook, 18 miles east of Yarloop (Slevin, 1955). Loveridge (1935) gives many localities, all similar to those listed.

NORTHERN TERRITORY RECORDS

The British Museum (Natural History) has specimens of the *raniformis* type from:

Port Essington (Nos. R.R.1936.12.13.135-1936.12.13.141)

I would not believe the locality to be correct, were it not for the fact that Copland (1957) has seen specimens from Darwin, and Loveridge (1949) had specimens from Knuckey's Lagoon, which is 9 miles from Darwin.

These are remarkable records, as reference to figure 70 shows. The Northern Territory populations are separated by a distance of at least 1500 miles from the areas in Western Australia and New South Wales where its relatives occur. Are these really the same biological species as either *Hyla aurea* or *Hyla moorei*? Is the absence of *Hyla aurea* from Queensland real or is it a matter of insufficient collecting?

COMMENTS

Hyla aurea ulongae Loveridge (1950) was described from a single specimen collected by Slevin at Ulong, New South Wales. The type is in the Australian Museum (No. 13817). I studied it very briefly but reached no conclusion regarding its status. Copland (1957) has redescribed it. Slevin (1955) gives a note about its history.

Hyla blandsuttoni was described by Procter (1924) from a living individual in the London Zoo that was thought to be from Queensland.

She believed it to be closely related to *Hyla aurea*. The individual was to have been given to the British Museum (Natural History), but there is no record of its ever having been received. Loveridge (1935) reported an individual (Museum of Comparative Zoölogy No. 3525) from Sydney. I have examined this specimen and find that it is the *aurea* form of *Hyla aurea*. Copland (1957) discusses the status of *Hyla blandsuttoni* at length and concludes that it is a synonym of *Hyla aurea aurea*.

There are points, however, in Procter's description that make it difficult to see how her new species can be *Hyla aurea*. The back is iridescent bronze, and the concealed surfaces are a brilliant turquoise blue. The first finger is slightly longer than the second. The illustration shows the individual in an arboreal position. *Hyla aurea* differs in all of these respects. Finally, *Hyla aurea* is unknown in Queensland, which may not be a valid objection, as the place of origin of *Hyla blandsuttoni* is in doubt.

I hesitate to make *Hyla blandsuttoni* a synonym of *Hyla aurea*. The whereabouts of the type is unknown, so the matter cannot be settled. The status of the species is in so much doubt, however, that it seems unwise to keep it on the list of Australian frogs.

Two other names, *Litoria punctata* and *Litoria marmorata* of Duméril (1853), have been problems ever since they were first used.

Litoria punctata was described from a single individual secured by Verreaux in the environs of Sydney. Duméril and Bibron (1854) mention it. It was also described by Günther (1858) and listed by Keferstein [1868a, as *Hyla (Litoria?) punctata*]. Cope (1866) uses the name *Hyla dimolops* without explanation. In a footnote to a later paper (1869) he writes: "Two species were described by Duméril as *L. marmorata* and *L. punctata*. On the union of these with *Hyla*, I changed their names to *H. tylosticta* and *H. dimolops* respectively (Jour. A. N. Sci. 1866, p. 85), as there were *Hylae* already described under those names." Boulenger (1882) described it under Cope's name, *Hyla dimolops*. Various writers referred to it from time to time (such as Krefft, 1863, and Fletcher, 1889), but always as a name only. No one was sure he had a specimen. Nieden (1923) continued to list it. Finally, Loveridge (1935) and Copland

(1957) list it as a synonym of *Hyla latopalmata*.

The type is in the Muséum National d'Histoire Naturelle in Paris (No. 758), according to Guibé (1950?), and I had the opportunity to examine it. It is not *Hyla latopalmata*, and, much to my surprise, it seems to be *Hyla cyclorhynchus*. At the time the examination was made, I had one of the syntypes of *Hyla cyclorhynchus* with me, so an exact comparison was possible. The type of *Litoria punctata* has the same spots on the flanks and the back as *Hyla cyclorhynchus*; in fact, the pattern is the same except that the belly of *punctata* is not vermiculated. The structure of the hand, foot, and vomerines is the same except that the finger pads of *cyclorhynchus* are slightly larger. The dimensions in millimeters of the type of *punctata* are: body length, 61.8; tibia length, 30.4; head length, 21.9; head width, 20.9. (The head is somewhat misshapen, so the measurements of it may not be accurate.)

Litoria marmorata Duméril (1853) is based on two individuals from "Nouvelle-Hollande." It is mentioned by Duméril and Bibron (1854). Günther (1858) also describes it, and it is listed by Keferstein [1868a, as *Hyla (Litoria) marmorata*]. If this frog is a *Hyla*, the name *marmorata* is preoccupied. Cope (1866) used the name *Hyla hyposticta*, without indicating that it was new or to what it referred. Later (1869) he says that his name *Hyla thyposticta* of 1866 was a new name for *Litoria marmorata*. (The actual quotation is given above in the discussion of *Litoria punctata*.) Perhaps his first name was a *lapsus calami*. Boulenger (1882) merely lists *Litoria marmorata* and *Hyla thyposticta* in a footnote with uncertain species. Nieden (1923) does the same. Krefft (1863) and William K. Parker (1881) mention it.

The type material is also in the Muséum National d'Histoire Naturelle in Paris [Guibé, (1950?)]. There are two specimens with the No. 757, which I examined. They also seem to be *Hyla cyclorhynchus*. They differ from *Litoria punctata* and resemble *Hyla cyclorhynchus* in having a reticulated abdominal pattern. The dimensions in millimeters are as follows: First specimen: body length, 48.8; tibia length, 22.2; head length, 16.5; head width, 16.8. Second specimen: body length,

53.2; tibia length, 25.3; head length, 19.6; head width, 18.9.

We have the problem of deciding on the proper name for the western species now known as *Hyla cyclorhynchus*. This has interesting legalistic aspects, but, in the cause of stability and common sense, I suggest that we continue to use *Hyla cyclorhynchus* for the following reasons. *Hyla cyclorhynchus* is now thought to occur only along the south coast of Western Australia (fig. 70). Because Duméril's *Litoria punctata* was said to be from Sydney, either it is not conspecific with *Hyla cyclorhynchus* or the locality is in error. There is not a similar difficulty with Duméril's *Litoria marmorata*, as it is said to be from "Australia."

Duméril's names of 1853, *punctata* and *marmorata*, are preoccupied and thus unavailable. Cope's names of 1866, *dimolops* and *hyposticta*, are *nomina nuda*. His names of 1869, *Hyla dimolops* for *Litoria punctata* and *Hyla thyposticta* for *Litoria marmorata*, deserve consideration. The fact of the matter is, however, that these names have never been applied to specimens other than the types (except erroneously by Loveridge). *Hyla dimolops* was a mystery, and *Hyla thyposticta* was largely forgotten. Furthermore, Sydney as a type locality for *Hyla dimolops* is an impossibility.

Boulenger's name of 1882, *cyclorhynchus*, has since been the name applied to the southwest Australian form. No one has suggested that *dimolops* and *thyposticta* might also apply. Clearly *Hyla cyclorhynchus* has "squatter's rights" as recognized by the "fifty year rule."

LITERATURE

This species made its scientific appearance as *Rana aurea* (Lesson, 1830). The type locality is the Macquarie River at Bathurst. Fortunately, Lesson provided an excellent illustration of the adult, which shows his species to be of the *aurea* type.

The many synonyms for *Hyla aurea* are here dealt with first.

Ranoides jacksoniensis was a name given by Tschudi ("1839" [1838]) to a species that was later described by Duméril and Bibron (1841) as *Hyla jacksoniensis*. The type locality is Port Jackson (= Sydney). Duméril and

Bibron were aware that their species was the same as Lesson's *Rana aurea*. The holotype is No. 4857 in the Muséum National d'Histoire Naturelle in Paris. Guibé (1950?) lists No. 4858 as the type, but the label on No. 4857 states that it is the type. In Duméril and Bibron (1854) the species is referred to as *Hyla jacksonii*. Fitzinger (1843, 1861) uses the name *Auletris jacksoniensis*. His *Auletris jacksoniensis* of 1861 includes *Rana caerulea* White as well as *Hyla jacksoniensis*.

Girard (1853) described as new *Ranoidea resplendens* from "Wollongong Illawara near the coast" and *Ranoidea flavoviridis* from "Wollongong Illawara; about fresh water streams." These were collected by the United States Exploring Expedition under the command of Capt. Charles Wilkes. The first has been long regarded as a synonym of *Hyla aurea*. The second was so regarded by Keferstein (1868a), but later authors, such as Boulenger (1882), Nieden (1923), Loveridge (1935), and Copland (1957), have ignored it entirely. From the description alone it seems reasonable enough that *Ranoidea resplendens* is *Hyla aurea*, but I would guess that *Ranoidea flavoviridis* is *Hyla lesueuri*. Girard re-described these two species in 1858, with illustrations of *Ranoidea resplendens* that show it to be the *aurea* type of *Hyla aurea*. Girard also uses the name *Ranoidea aurea* to include *Rana aurea* Lesson, *Ranoidea jacksoniensis* Tschudi, and *Hyla jacksoniensis* Duméril and Bibron.

I have examined the types of Girard's species, which are now in the United States National Museum. *Ranoidea resplendens* (No. 15478) is indeed *Hyla aurea*. The specimen is an adult female. The pigmentation pattern has faded badly, but it seems to be of the *aurea* type, as would be expected from the locality where the specimen was taken. One of the types of *Ranoidea flavoviridis* is *Hyla lesueuri*. (For further information, refer to the section on *Hyla lesueuri*.)

Günther (1864a, 1864b) suggested that *Hyla aurea* should be *Litoria aurea*.

Keferstein (1867) described *Chirodrys raniformis* from Australia. No more specific locality is indicated, but he mentions in the introduction to his paper that his Australian frogs were received from Dr. Schuette, a practicing physician of Sydney, and from the

Australian Museum through Mr. Krefft. It is probable, but by no means certain therefore, that *Chirodrys raniformis* came from New South Wales. The following year Keferstein (1868a) wrote, "Jetzt stehen mir über hundert Exemplare von *H. aurea*, von allen Grössen zur Verfügung und ich sehe, dass der *Chirodrys raniformis* nur ein altes Exemplar der *H. aurea* ist."

The long-forgotten *Hyla castanea* of Steindachner ("1869" [1867]), with illustrations of the dorsal and ventral sides of the adult, open mouth, hand, and foot) is similar enough to some individuals of *raniformis* type from south-central New South Wales to be regarded as the same. The locality is unknown, but the single specimen was secured, together with many other Australian species, on the "Novara" expedition. Boulenger (1882) includes the name in a list of species he did not know what to do with. I have not seen it referred to again in any paper on Australian frogs.

Fanchonia elegans described by Werner (1893) from tropical Africa was later shown to be no more than a "defectes und deformiertes Exemplar" of *Hyla aurea* (Werner, 1897a).

H. W. Parker (1938) recognized two subspecies, *Hyla aurea aurea* and *Hyla aurea raniformis*. Loveridge (1950) described a third subspecies, *Hyla aurea ulongae*, from Ulong, New South Wales. Moore (1954a) showed that east Australian frogs of the *aurea* type are specifically different from the *raniformis* type of Western Australia. Copland (1957) recognizes *Hyla aurea aurea*, *Hyla aurea raniformis*, *Hyla aurea ulongae*, as well as a new subspecies from Tasmania, *Hyla aurea major*. Furthermore, a new name, *Hyla moorei*, is given for the *raniformis*-like individuals of Western Australia.

Additional descriptions of *Hyla aurea*, which generally include one or more races and *Hyla moorei*, are given by Günther (1858), Keferstein (1868a, with an illustration of an adult of *raniformis* type and the skull), Steindachner ("1869" [1867]), McCoy (1881, as *Ranoidea aurea*, with many colored illustrations), Boulenger (1882), Gadow (1901), Lucas and Le Souëf (1909, with a photograph of an adult), English (1910), Fry (1914), Richard Deckert (1915, with a photograph

of an adult), Nieten (1923, with a drawing of the foot), Lord and Scott (1924), Waite (1929), Loveridge (1934, 1935, 1949), Scott (1942), Moore (1957a, with a photograph of an adult of *aurea* type), and Copland (1957).

Geographical data are given by Fletcher (1890, 1891a, 1892, 1894b, 1898) and Lucas (1892, 1897).

Habits are discussed by Krefft (1863), Fletcher (1889), and Harrison (1922).

Mention of its introduction into New Zealand is made by Marriner (1907).

The habits in captivity are discussed by Klingelhöffer (1931, 1956 and Mandeville (1952, with a photograph).

A general account of the anatomy is given by Briggs (1934). Other anatomical papers are concerned with the spinal cord (Sweet, 1897), vertebral column (Nicholls, 1916), scapula (Procter, 1921), hyoid and larynx (Trewavas, 1933), truncus arteriosus (Oliver, 1909), urinogenital organs (Sweet, 1908), depressor mandibulae muscle (Griffiths, 1954), motor mechanisms of the brain (Abbie and Adey, 1950), herniation (Richardson, 1947), and minor anatomical features (Cope, 1866, as *Ranoidea aurea*).

Hybridization studies have been reported by Moore (1954a, 1954b, 1955). A criticism

of the use of hybridization technique to recognize species was made by Rabb and Mosimann (1956), and a reply was given by Moore (1956).

References on parasites are Johnston (1912) and Brace (1953).

Fleay (1935, 1951) gives an account, with illustrations, of *Hyla aurea* eating young tiger snakes.

Minor mention is made by Aflalo (1896), Barrett (1943), Boettger (1892), Chisholm (1925), Kesteven (1944), Krefft (1869), Smith (1929), Spencer (1892), Andersson (1913a), Fry (1912), Krefft (1862, 1865; 1867, 1870, as *Litoria aurea*), Gray [1841a, and fig. 3 of pl. 8 (?) which, though unlabeled, would seem to be of an adult of *raniformis* type], Thomas (1958), Kinghorn (1944, 1956), Ross (1908a), Duméril (1853, as "rainette de Jackson"), and McCoy (1867, as *Ranhyla aurea*).

References that apply entirely or principally to the Western Australian species *Hyla moorei*, according to Copland (1957), are Main (1954a), Slevin (1955, with a photograph of an adult), Glauert (1929, 1945), Kinghorn (1924), Taylor (1935), Fraser (1903), Mertens (1958a with a drawing of an adult), and Werner (1914).

KEYS TO THE FROGS OF EASTERN NEW SOUTH WALES

AS AN AID to the identification of New South Wales frogs, keys to the Leptodactylidae and Hylidae are provided.

The keys are designed for eastern New South Wales individuals. This geographical limitation must be remembered, because they will not always be reliable for individuals from other areas.

Some of the characters used in the keys, as well as other data useful in the determination of species, are collected in tables 7 and 8. Neither the keys nor these tables indicate the variation in the characters, so, for a final check of an identification, the description and illustrations of the species should be consulted.

The method used in tables 7 and 8 for indicating the position of the vomerine teeth requires an explanation. Five positions are recognized: (1) anterior to the level of the front edge of the choanae; (2) level with the front edge of the choanae; (3) between the choanae; (4) level with the hind edge of the choanae; and (5) posterior to the level of the

hind end of the choanae. The positions of both the anterior edge and the posterior edge of the vomerine teeth are given. Thus, if the vomerine teeth are entirely behind the choanae, their position is expressed as 5-5. To give another example: if the anterior edge of the vomerine teeth is level with the front of the choanae and the posterior edge level with the hind edge of the choanae, the position is 2-4.

In the Key to the Hylids, the species of *Hyla* are divided into groups, some that are probably natural, others that are surely artificial. The groups are arranged, in a rough way, beginning with those that are characterized by broad heads, large discs on the fingers and toes, extensive webbing, and a uniform coloration pattern on the back and progressing to those with narrower heads, smaller discs, less webbing, and more distinctive patterns.

The character "phalanges of the fourth toe free" in the Key to the Hylids and table 8 means the phalanges behind the disc.

KEY TO THE LEPTODACTYLIDS

1. Vomerine teeth present 2
Vomerine teeth absent 16
2. Anterior edge of vomerine teeth level with anterior edge of choana 3
Anterior edge of vomerine teeth at or behind level of posterior edge of choana 6
3. Inner metatarsal tubercle intensely black. Eye with vertically slit pupil. Back irregularly mottled. Maximum size, 50 mm. (Pl. 35, fig. 2; p. 183.) . . . *Neobatrachus pictus*
Inner metatarsal tubercle not intensely black 4
4. Thumb opposable and much longer than second finger. Usually a pale middorsal stripe. Slight webbing between toes. Maximum size, 65 mm. (P. 34, fig. 1; p. 166.)
Thumb not opposable 5
5. Webbing between toes moderately developed. Cross bars on appendages. Inner metatarsal tubercle no longer than first toe. Maximum size, 101 mm. (Pl. 33, fig. 1; p. 162.)
No more than trace of webbing between toes. No cross bars on appendages. Inner metatarsal tubercle much longer than first toe. A tiny flap of skin at anterior corner of eye. Maximum size, 93 mm. (Pl. 35, fig. 1; p. 179.) *Heleioporus australiacus*
6. Slight webbing between fingers 7
No web between fingers 8
7. A sharply defined skin fold extending from snout along side of body to level of arm. Abdomen whitish. Tibia length/body length ratio more than 0.50. Maximum size, 50 mm. (Pl. 34, fig. 3; p. 169.)
No sharply defined skin fold extending from snout to level of arm. Orange-red patches in groin and on posterior surface of tibial section of leg in living animals. Abdomen usually darkly mottled. In many specimens a "butterfly"-shaped spot between eyes. Males with large tusks in lower jaw. Tibia length/body length ratio less than 0.50. Maximum size, 50 mm. (Pl. 34, fig. 4; p. 174.) *Lechriodus fletcheri*
8. Inner metatarsal tubercle longer than first toe and shovel-shaped (nearly a hemisphere) . 9
Inner metatarsal tubercle not longer than first toe and not shovel-shaped 10
9. A large gland on tibial section of leg. A yellow

TABLE 7
MORPHOLOGICAL FEATURES OF NEW SOUTH WALES LEPTODACTYLIDS

	Maximum Body Length	Tibia Length/Body Length	Head Length/Body Length	Head Width/Head Length	Vomerine Anterior Edge	Teeth Posterior Edge	Phalanges of Fourth Toe Free	Finger Web	Finger Length
<i>Mixophyes fasciolatus</i>	101	0.64	0.42	1.07	2	4	2-3	None	3>1≥2=4
<i>Cyclorana alboguttatus</i>	65	0.49	0.41	1.00	2	4	3	None	3>4=1>2
<i>Lechriodus fletcheri</i>	50	0.59	0.36	1.06	5	5	4	Slight	3>2>1≥4
<i>Adelotus brevis</i>	50	0.42	♀ 0.38 ♂ 0.50	0.99	5	5	4	Trace	3>2≥4>1
<i>Heleioporus australiacus</i>	93	0.34	0.36	1.23	3	4	4	None	3>1>2>4
<i>Neobatrachus pictus</i>	50	0.34	0.34	1.16	2	4	2-3	None	3>1>2≥4
<i>Limnodynastes dorsalis</i>	87	0.38	0.36	1.21	5	5	4	None	3>2>1=4
<i>Limnodynastes ornatus</i>	44	0.43	0.32	1.22	4	5	4	None	3>2=1>4
<i>Limnodynastes peroni</i>	64	0.47	0.33	1.03	5	5	4	None	3>2≥4≥1
<i>Limnodynastes tasmaniensis</i>	41	0.40	0.34	1.03	5	5	4	None	3>2>4>1
<i>Limnodynastes fletcheri</i>	56	0.43	0.35	1.02	5	5	4	None	3>2>1>4
<i>Limnodynastes salmini</i>	70	0.41	0.38	1.04	5	5	4	None	3>1>2=4
<i>Uperoleia marmorata</i>	31	0.38	—	—	0	0	4	None	3>4>2>1
<i>Kyarranus sphagnicolus</i>	34	0.44	0.31	1.15	4	5	4	None	3>2≥4>1
<i>Kyarranus loveridgei</i>	27	0.41	0.34	1.09	4	5	4	None	3>2≥4>1
<i>Crinia haswelli</i>	32	0.41	0.33	1.09	5	5	4	None	3>4>2>1
<i>Crinia signifera</i>	30	0.42	0.31	1.01	0	0	4	None	3>4=2>1
<i>Pseudophryne australis</i>	27	0.33	—	—	0	0	All	None	3>4>2>1
<i>Pseudophryne bibroni</i>	31	0.30	—	—	0	0	All	None	3>4>2>1
<i>Pseudophryne dendyi</i>	30	0.30	—	—	0	0	All	None	3>4>2>1
<i>Pseudophryne coriacea</i>	34	0.33	—	—	0	0	All	None	3>4>2>1
<i>Pseudophryne corroboree</i>	31	0.33	—	—	0	0	All	None	3>4>2>1

skin ridge extending from below eye to base of arm. Usually a pale glandular spot on each side of cloaca. Maximum size, 87 mm. (Pl. 35, figs. 3, 4; p. 187.)

10. Basal segment of thumb extending beyond basal segment of second finger . . . 11
11. Back with dark and light longitudinal stripes. Toes not webbed. Maximum size, 64 mm. (Pl. 36, figs. 2, 4; p. 197.)
12. Vomerine teeth extending laterally beyond level of inner edge of choana . . . 13
13. Second finger longer than first. Back with numerous spots. In many specimens a tiny outer metatarsal tubercle. Maximum size,

41 mm. (Pl. 37, fig. 3; p. 203.)

14. Flanges on toes (visible with magnification of ×6). Red spots on flanks and posterior surfaces of hind legs. Maximum size, 32 mm. (Pl. 39, fig. 3; p. 224.)
15. Throat heavily mottled. A horizontal brown stripe on flank. A horizontal black band extending from each side of cloaca to ventral surface of thigh. Maximum size, 34 mm. (Pl. 38, figs. 4, 5, 8; p. 214.)
16. Two metatarsal tubercles, outer as well developed as inner. Parotoid glands. Yellow or orange-red spots on anterior and posterior sides of thigh. Maximum size, 29 mm. (Pl. 38, fig. 3; p. 219.)

- ent, much smaller than inner. 17
17. With maxillary teeth. Toes with well-developed fringes (visible with magnification of 6X). A tiny white spot on ventral side at base of each arm. A pale spot at cloacal opening. Maximum size, 30 mm. (Pl. 39, fig. 4; p. 225.) *Crinia signifera*
No maxillary teeth. No fringes on toes 18
18. A red patch on crown. Maximum size, 27 mm. (Pl. 40, figs. 1-3, 7; p. 235.) *Pseudophryne australis*
No red patch on crown 19
19. Dorsal surface with boldly contrasting black and yellow longitudinal stripes. Maximum size, 31 mm. (Pl. 40, figs. 4, 5; p. 248.) *Pseudophryne corroboree*
No black and yellow longitudinal stripes on back 20
20. Dorsal surface uniform reddish. Sides much darker, usually black. Maximum size, 34 mm. (Pl. 40, figs. 10, 11; p. 247.) *Pseudophryne coriacea*
Dorsal surface as dark as or darker than sides 21
21. A bright yellow patch on upper arm and another extending laterally from cloaca but not including femoral glands at distal end of thigh. Maximum size, 30 mm. (Pl. 40, figs. 14, 15; p. 244.) *Pseudophryne dendyi*
No patch on upper arm or, if present, a dull yellow. In some specimens a yellow spot on posterior side of thigh but restricted to femoral gland. Maximum size, 31 mm. (Pl. 40, figs. 8, 9, 12, 13; p. 240.) *Pseudophryne bibroni*

KEY TO THE HYLIDS

1. The green tree frogs. Dorsal surface typically uniform leaf green (bluish after preservation). No distinctive pattern on hind surface of thigh. Second finger noticeably longer than first. At least a trace of webbing between fingers. A well-developed toe web, no more than one phalanx of fourth toe being free. Discs on fingers and toes well developed. Vomerine teeth, when present, usually projecting behind level of hind edge of choanae. Thumb not opposable.
- 1.1. Vomerine teeth absent.
- 1.11. A pale line (white or yellowish in life) extending along upper jaw from level of eye to shoulder. Flash markings on hind legs orange (in life). Maximum size, 33 mm. (Pl. 41, fig. 1; p. 251.) *Hyla bicolor*
- 1.12. A pale line (golden in life) extending from nostril across top of eye and tympanic membrane to shoulder. Flash markings on hind legs brick red (in life). Maximum size, 41 mm. (Pl. 41, fig. 2; p. 255.) *Hyla phyllochroa*
- 1.2. Vomerine teeth present.
- 1.21. Finger web reaches or nearly reaches disc of fourth finger. No horizontal white line on upper or lower jaw. Upper arm and back of hand with little or no green.
- 1.211. Canthus angular. Snout sharply angular when viewed from side. No green on upper arm. Green of lower arm restricted to sharply delimited oval patch. No green on thigh, dorsal surface being yellowish and posterior surface brownish. Maximum size, 44 mm. (Pl. 41, fig. 3; p. 265.) *Hyla gracilentia*
- 1.212. Canthus rounded. When viewed from side, snout rounded. Some green on dorsal surface of thigh and purple on posterior surface. Maximum size, 65 mm. (Pl. 42, fig. 2; p. 263.) *Hyla chloris*
- 1.22. Finger web vestigial or extending no more than halfway to tip of fourth finger.
- 1.221. A pale line (golden in life) extending from nostril across top of eye and tympanic membrane to shoulder. Flash markings on hind legs brick red (in life). Maximum size, 41 mm. (Pl. 41, fig. 2; p. 255.) *Hyla phyllochroa*
- 1.222. A white line on edge of lower jaw extending posteriorly to forearm. Tibia/body ratio 0.56 ± 0.01 (53-61). North Queensland. Maximum size, 129 mm. (Pl. 42, fig. 1; p. 267.) *Hyla infrafrenata*
- 1.223. No distinctive lines on upper jaw, lower jaw, or between nostril and eye. Heavy fold of skin overlapping top of tympanic membrane. Posterior surface of thigh tan (in life). Tibia/body ratio 0.42 ± 0.01 (0.39-0.45). Maximum size, 103 mm. (Pl. 41, fig. 4; p. 258.) *Hyla caerulea*
2. Other tree frogs with a broad head, little or no pattern on back, second finger noticeably longer than first, but *not green on dorsal surface*. Thumb not opposable.
- 2.1. Hind surface of thigh with black and yellow vermiculations. Large discs on fingers and toes. Well-developed webs; only one phalanx of third finger and fourth toe free. (Pl. 43, fig. 2; p. 268.) *Hyla peroni*

TABLE 8
MORPHOLOGICAL FEATURES OF NEW SOUTH WALES HYLIDS

	Maxi- mum Body Length	Tibia Length/ Body Length	Head Length/ Body Length	Head Width/ Head Length	Vomerine Teeth		Pha- langes of Fourth Toe Free	Finger Web	Finger Lengths
<i>Hyla bicolor</i>	33	0.51	0.31	0.97	0	0	0.5	Tiny	2 > 1
<i>Hyla phyllochroa</i>	41	0.52	0.34	1.06	3	5	1	Tiny	2 > 1
<i>Hyla caerulea</i>	103	0.42	0.29	1.20	4	5	1	Slight	2 > 1
<i>Hyla chloris</i>	65	0.52	0.32	1.12	3	5	1	Moderate	2 > 1
<i>Hyla gracilenta</i>	44	0.53	0.32	1.08	3	5	1	Moderate	2 > 1
<i>Hyla peroni</i>	65	0.51	0.31	1.00	2	4	1	Moderate	2 > 1
<i>Hyla citropa</i>	60	0.53	0.34	1.12	3	5	2	None	2 > 1
<i>Hyla dentata</i>	46	0.44	0.28	1.11	4	5	2	Tiny	2 > 1
<i>Hyla jervisiensis</i>	61	0.55	0.33	1.04	2	3	1.5	Tiny	2 > 1
<i>Hyla ewingi</i>	38	0.47	0.33	1.06	2	3	2	Tiny	2 > 1
<i>Hyla booroolongensis</i>	51	0.55	0.35	1.08	2	5	1	None	2 > 1
<i>Hyla lesueuri</i>	68	0.63	0.36	1.05	2	4	1	None	1 = 2
<i>Hyla latopalmata</i>	43	0.63	0.37	0.98	2	3	2	None	1 > 2
<i>Hyla freycineti</i>	49	0.64	0.37	0.94	2	3	2	None	1 = 2
<i>Hyla nasuta</i>	55	0.70	0.37	0.82	2	3	2	None	1 = 2
<i>Hyla aurea</i>	92	0.50	0.34	0.92	2	5	1.5	None	2 > 1

- 2.2. No pattern on hind surface of thigh. Finger and toe discs of moderate size. A sharp ridge along canthus rostralis and from eye to arm. A fleshy area below ridge (posterior to eye). No finger web. Maximum size, 60 mm. (Pl. 43, fig. 3; p. 272.) *Hyla citropa*
3. Tree frogs with broad longitudinal patch on back. Second finger noticeably longer than first. Fingers with vestigial webs. Thumb not opposable.
- 3.1. Dorsal patch extending from snout nearly to cloaca. Narrower at level of arms and middle of abdomen. Well-developed discs on fingers and toes. Maximum size, 46 mm. (Pl. 43, fig. 4; p. 275.) *Hyla dentata*
- 3.2. Dorsal patch extending from level of eyes to cloaca. (See table 4, p. 281.)
- 3.21. Finger discs noticeably wider than fingers. Tibia/body ratio, 0.47 (0.43–0.51). Maximum size, 38 mm. (Pl. 44, fig. 3; p. 284) *Hyla ewingi*
- 3.22. Finger discs about same width as fingers. Tibia/body ratio, 0.55 (0.53–0.57). Adults usually more than 45 mm. in body length. Maximum size, 61 mm. (Pl. 43, fig. 1; p. 281.) *Hyla jervisiensis*
4. Ground hylas of *lesueuri* group. First and second fingers of nearly same length. Finger and toe discs very small. In most specimens a dark band across wrist. No finger webs. Thumb opposable. Vomerine teeth between choanae. (See table 6, p. 310.)
- 4.1. Second finger slightly longer than first. Discs on fingers noticeably wider than fingers. Fifth toe webbed to disc. Tibia/body ratio less than 0.60. Lateral head stripe absent or inconspicuous. Maximum size: female 51 mm.; male, 38 mm. (Pl. 45, fig. 1; p. 292.) *Hyla booroolongensis*
- 4.2. First and second fingers of equal length. Fifth toe with disc and part of one phalanx free. Tibia/body ratio 0.60–0.65. No vertical white bar immediately anterior to eye. Posterior head stripe half of width of tympanum. Posterior side of thigh black, with pale spots or blotches. Maximum size: female, 68 mm.; male, 44 mm. (Pl. 45, fig. 4; p. 294.) *Hyla lesueuri*
- 4.3. Dark band from eye to arm and as wide as tympanum. Outer metacarpal tubercle not nicked or split. First finger slightly longer than second. Hind surface of thigh yellow (in life), with black reticulum. Maximum size, 43 mm. (Pl. 45, fig. 3; p. 298.) *Hyla latopalmata*
- 4.4. First and second fingers of equal length. Outer metacarpal tubercle only nicked. Broad dark band from snout to eye. This in almost all specimens cut by vertical white bar anterior to eye. Top of snout pale, with or without darker central spot. Back usually with shallow, oval warts. Pigment

- pattern of hind surface of thigh not a series of horizontal bands. Maximum size, 49 mm. (Pl. 46, fig. 2; p. 302.) *Hyla freycineti*
- 4.5. Head very narrow and pointed. Legs long. Tibia/body ratio, 0.67–0.73. Back usually with longitudinal skin folds. Outer metacarpal tubercle split for half of length. Horizontal stripes on posterior side of thigh. Maximum size, 55 mm. (Pl. 45, fig. 2; p. 305.) *Hyla nasuta*
5. Ground hylas of *aurea* group. Second finger noticeably longer than first. No finger webs. Thumb opposable. Back green, with brown spots. Yellow dorsolateral fold.
- 5.1. Back smooth. No middorsal stripe. Maximum size, 78 mm. (Pl. 46, fig. 1; p. 313.) *Hyla aurea aurea*
- 5.2. Back with warts. Generally a pale middorsal stripe. Maximum size, 94 mm. (Pl. 46, fig. 3; p. 314.) *Hyla aurea raniformis*

A SYNOPTIC LIST OF AUSTRALIAN AMPHIBIANS

SUCH A HIGH PROPORTION of the species of Australian amphibians is described in detail or their status discussed, that it may be useful to give a full list of the species and their distributions. The last attempt to list the Australian amphibians was that of Loveridge (1935), and there have been many changes in recent years.

The basis of the list (table 9) is my own work supplemented by H. W. Parker's (1934, 1940) monographs on the Microhylidae and Leptodactylidae, Loveridge's (1935) account of the Australian Amphibia in the Museum of Comparative Zoölogy, Copland's (1957) monograph on the Hylidae, and the recent papers of Main and his associates.

In table 9 the species are arranged alphabetically within their respective genera. Subspecies are not listed except in the case of *Hyla aurea*, of which it seems likely, but by no means established, that the forms are actually full species. It will be noticed that some of the species are numbered and some are not. Those given a number are thought to be valid, with the usual reservation of such a judgment in taxonomy. There are 94 of these, including one subspecies. Doubtful species, of which there are 16, are not numbered. They are entered in table 9 near the species that they are thought to resemble.

An asterisk is placed before those species that I have not studied and therefore list with little authority.

The geographic range is indicated briefly. For those species treated in detail in this report, full data are given in the accounts of the species.

There are problems concerning the proper name for the one *Rana* and two species of *Hyla* that occur in northern Queensland. Apparently only one species of *Rana* occurs in northern Queensland. The first record of an Australian *Rana* is that of Steindachner (1868) who described as new *Hylorana daemeli* from Cape York. In 1877 Macleay described *Hylarana nebulosa*, also from Cape York. A third and last description of a *Rana*

based on Australian specimens was of *Hyla nobilis* from Cape York (de Vis, 1884b).

In 1882, Boulenger made *Hylorana daemeli* and *Hylarana nebulosa* synonyms of *Rana papua*. The last was described by Lesson (1830) from Waigiou Island off northwestern New Guinea. In 1885 Boulenger added *Hyla nobilis* to the same synonymy.

In 1914, 1918, and 1920 Boulenger used the name *Rana daemeli* for the north Queensland frogs. He believed that the species occurs in New Guinea as well. Loveridge (1935) referred to the Queensland frogs as *Rana papua papua* and later (1948) as *Rana grisea grisea*. The last was described by van Kampen (1913) from the Went Mountains of Netherlands New Guinea.

So far as I know, no one has compared the types of *Hylorana daemeli*, *Rana papua*, and *Rana grisea*. Until such a comparison has been made, the most reasonable solution is to use the oldest available name and to call the Australian frogs *Rana daemeli*.

There is a similar problem with two of the Queensland species of *Hyla*. Both Loveridge (1935) and Copland (1957) make *Hyla serrata* (from Carrington and Atherton) a synonym of *Hyla eucnemis*. The last was described by Lönnberg (1900) from Sattelberg, which is on the Huon Peninsula of northeast New Guinea. *Hyla nannotis* (from Tully River, north Queensland) is regarded by Loveridge (1935) as a synonym of *Hyla obsoleta*. The last was described by Lönnberg (1900) from Simbang, also on the Huon Peninsula.

Dr. Richard G. Zweifel tells me that it would be most unusual for a species to have a pattern of distribution that includes northeast Queensland and the Huon Peninsula but not the intervening area. The species that are shared by Australia and New Guinea in nearly every case occur only in southern New Guinea. I think it better, therefore, to regard both *Hyla serrata* and *Hyla nannotis* as valid. The attempts to make them synonyms of *Hyla eucnemis* and *Hyla obsoleta*, respectively, seem premature.

TABLE 9
A SYNOPTIC LIST OF AUSTRALIAN AMPHIBIANS

Family Leptodactylidae	
1. <i>Mixophyes fasciolatus</i> Günther	East coasts of Queensland and New South Wales
2. <i>Cyclorana alboguttatus</i> (Günther)	Queensland, New South Wales, and Northern Territory
3. <i>Cyclorana australis</i> (Gray)	Northern Western Australia, Northern Territory, and Queensland
4. * <i>Cyclorana brevipes</i> (Peters)	Eastern Queensland
5. * <i>Cyclorana cultripes</i> Parker	Interior of New South Wales, Northern Territory, and northern Western Australia
6. * <i>Cyclorana dahli</i> (Boulenger)	Northern Territory
7. * <i>Cyclorana inermis</i> (Peters)	Eastern Queensland
8. * <i>Cyclorana platycephalus</i> (Günther)	Interior of Australia (Western Australia, Northern Territory, South Australia, and New South Wales)
9. * <i>Cyclorana slevini</i> Loveridge	Southeast Queensland
10. <i>Lechriodius fletcheri</i> (Boulenger)	East coasts of New South Wales and Queensland (also New Guinea)
11. <i>Adelotus brevis</i> (Günther)	East coasts of New South Wales and southern Queensland
12. <i>Neobatrachus centralis</i> (Parker)	South Australia, Northern Territory, and Western Australia
13. * <i>Neobatrachus pelobatoides</i> (Werner)	Southwest Western Australia
14. <i>Neobatrachus pictus</i> Peters	Queensland, New South Wales, Victoria, and South Australia
15. * <i>Neobatrachus sutor</i> Main	Southwest Western Australia
16. * <i>Neobatrachus wilsmorei</i> (Parker)	Southwest Western Australia
17. * <i>Heleioporus albopunctatus</i> (Gray)	Southwest Western Australia
18. <i>Heleioporus australiacus</i> (Shaw)	Vicinity of Sydney, New South Wales, and southwest Western Australia
19. * <i>Heleioporus eyrei</i> (Gray)	Southwest Western Australia
20. * <i>Heleioporus inornatus</i> Lee and Main	Southwest Western Australia
21. * <i>Heleioporus psammophilus</i> Lee and Main	Southwest Western Australia
22. <i>Limnodynastes convexiusculus</i> (Macleay)	Queensland, Northern Territory, and New Guinea
23. <i>Limnodynastes dorsalis</i> (Gray)	Australia except the center
<i>Limnodynastes dumerili</i> (Peters)	New South Wales, Victoria, Tasmania, and South Australia
<i>Limnodynastes terraereginae</i> (Fry)	Queensland
<i>Limnodynastes grayi</i> (Steindachner)	Eastern New South Wales
24. <i>Limnodynastes fletcheri</i> Boulenger	Southern Queensland and interior of New South Wales
25. <i>Limnodynastes ornatus</i> (Gray)	All states except Victoria and Tasmania
<i>Limnodynastes spenceri</i> Parker	Interiors of Northern Territory, South Australia, and Western Australia
26. <i>Limnodynastes peroni</i> (Duméril and Bibron)	East coast of Australia and Tasmania
27. <i>Limnodynastes salmini</i> Steindachner	Queensland and New South Wales
28. <i>Limnodynastes tasmaniensis</i> Günther	Queensland, New South Wales, Victoria, Tasmania, and South Australia
29. <i>Philoria frosti</i> Spencer	Mt. Baw Baw, Victoria
30. <i>Kyarranus loveridgei</i> (Parker)	Southeastern Queensland
31. <i>Kyarranus sphagnicolus</i> Moore	Northern New South Wales
32. * <i>Notaden bennetti</i> Günther	Interiors of New South Wales and southern Queensland
33. * <i>Notaden nicholli</i> Parker	Northern Western Australia
34. * <i>Glauertia mjobergi</i> (Andersson)	Noonkambah, Kimberley Division, Western Australia
35. * <i>Glauertia russelli</i> Loveridge	Gascoyne River, near Landor Station, Western Australia
* <i>Glauertia orientalis</i> Parker	Northern Territory

TABLE 9—(Continued)

36. <i>Uperoleia marmorata</i> Gray	Western Australia, Northern Territory, Queensland, and New South Wales
<i>Uperoleia rugosa</i> (Andersson)	Queensland and interior of New South Wales
37. <i>Crinia acutirostris</i> Andersson	Northeast Queensland
38. * <i>Crinia darlingtoni</i> Loveridge	Southeast Queensland
39. <i>Crinia georgiana</i> Tschudi	Southwest Western Australia
40. <i>Crinia glauerti</i> Loveridge	Southwest Western Australia
41. <i>Crinia haswelli</i> Fletcher	Southeast New South Wales and eastern Victoria
42. <i>Crinia insignifera</i> Moore	Southwest Western Australia
43. <i>Crinia laevis</i> (Günther)	Tasmania and Victoria
<i>Crinia victoriana</i> Boulenger	Victoria
44. <i>Crinia leai</i> Fletcher	Southwest Western Australia
45. * <i>Crinia parinsignifera</i> Main	Lower Murray Valley of Victoria, New South Wales, and South Australia
46. * <i>Crinia pseudinsignifera</i> Main	Southwest Western Australia
47. <i>Crinia rosea</i> Harrison	Southwest Western Australia
48. <i>Crinia signifera</i> Girard	Northern and eastern halves of Australia (and New Guinea)
49. * <i>Crinia sloanei</i> Littlejohn	Murray River Valley of New South Wales and Victoria
50. * <i>Crinia subinsignifera</i> Littlejohn	Southwest Western Australia
51. <i>Crinia tasmaniensis</i> (Günther)	Tasmania
52. * <i>Myobatrachus gouldi</i> (Gray)	Southwest Western Australia
53. * <i>Metacrinia nicholli</i> (Harrison)	Southwest Western Australia
54. <i>Pseudophryne australis</i> (Gray)	Vicinity of Sydney, New South Wales
55. <i>Pseudophryne bibroni</i> Günther	Southern Queensland, New South Wales, Victoria, Tasmania, and South Australia
56. <i>Pseudophryne coriacea</i> Keferstein	Northeast New South Wales and eastern Queensland
57. <i>Pseudophryne corroboree</i> Moore	Mountains of southeast New South Wales
58. <i>Pseudophryne dendyi</i> Lucas	Southeast New South Wales and eastern Victoria
59. * <i>Pseudophryne guentheri</i> Boulenger	Southwest Western Australia
60. * <i>Pseudophryne major</i> Parker	Eastern Queensland
61. * <i>Pseudophryne occidentalis</i> Parker	Southwest Western Australia
62. * <i>Pseudophryne semimarmorata</i> Lucas	Victoria and Tasmania
63. <i>Bufo marinus</i> (Linnaeus)	Family Bufonidae Queensland (introduced)
64. <i>Hyla adelaidensis</i> Gray	Family Hylidae Southwest Western Australia and possibly the Northern Territory
65. <i>Hyla aurea aurea</i> (Lesson)	Eastern New South Wales
<i>Hyla aurea ulongae</i> Loveridge	Ulong, New South Wales
66. <i>Hyla aurea raniformis</i> (Keferstein)	South Australia, Victoria, Tasmania, and interior of New South Wales
* <i>Hyla blandsuttoni</i> Procter	?Queensland
67. <i>Hyla bicolor</i> (Gray)	Northern Western Australia, Northern Territory, Queensland, and New South Wales
68. <i>Hyla booroolongensis</i> Moore	Mountains of New South Wales
69. * <i>Hyla burrowsi</i> Scott	Cradle Valley, Tasmania
70. <i>Hyla caerulea</i> (White)	Northern Western Australia, Northern Territory, Queensland, and New South Wales (also in New Guinea)
71. <i>Hyla chloris</i> Boulenger	East coasts of Queensland and northern New South Wales

TABLE 9—(Continued)

72. <i>Hyla citropa</i> (Tschudi)	Eastern New South Wales and Victoria
* <i>Hyla maculata</i> Spencer	Powong, Victoria
73. <i>Hyla cyclorhynchus</i> (Boulenger)	South coast of Western Australia
74. * <i>Hyla dayi</i> Günther	Northeast Queensland
* <i>Hyla tympanocryptis</i> Andersson	Northeast Queensland
75. <i>Hyla dentata</i> Keferstein	Eastern New South Wales
76. <i>Hyla ewingi</i> Duméril and Bibron	Queensland, New South Wales, Victoria, Tasmania, and eastern South Australia
77. <i>Hyla freycineti</i> (Tschudi)	East coasts of New South Wales and Queensland
78. <i>Hyla gracilentia</i> Peters	East coasts of Queensland and northern New South Wales
* <i>Hyla irrorata</i> de Vis	East coast of Queensland
79. <i>Hyla infrafrenata</i> Günther	Northeast Queensland (and New Guinea)
80. <i>Hyla jervisiensis</i> Duméril and Bibron	Eastern New South Wales
81. <i>Hyla latopalmata</i> (Günther)	Northern Western Australia, Northern Territory, Queensland, and New South Wales
<i>Hyla kinghorni</i> Loveridge	Ulong, New South Wales
82. <i>Hyla lesueuri</i> Duméril and Bibron	Queensland, New South Wales, and Victoria
<i>Hyla nigrofrenata</i> Günther	Northern Queensland and Northern Territory
<i>Hyla vinosa</i> Lamb	Southeast Queensland
83. <i>Hyla moorei</i> Copland	Southwest Western Australia
84. * <i>Hyla nannotis</i> Andersson	Northeast Queensland
85. <i>Hyla nasuta</i> (Gray)	Northern Western Australia, Northern Territory, Queensland, and New South Wales (also in New Guinea)
86. <i>Hyla peroni</i> (Tschudi)	All states except Tasmania
* <i>Hyla jenolanensis</i> Copland	Jenolan Caves, New South Wales
87. <i>Hyla phyllochroa</i> Günther	Eastern New South Wales and southeast Queensland
88. <i>Hyla rubella</i> Gray	All states except Victoria and Tasmania
89. * <i>Hyla serrata</i> Andersson	Northeast Queensland
Family Ranidae	
90. <i>Rana daemeli</i> (Steindachner)	Northeast Queensland (and New Guinea)
Family Microhylidae	
91. * <i>Sphenophryne gracilipes</i> (Fry)	Northeast Queensland (and New Guinea)
92. * <i>Sphenophryne polysticta</i> (Méhely)	Northeast Queensland (and New Guinea)
93. * <i>Sphenophryne robusta</i> (Fry)	Northeast Queensland
94. * <i>Cophixalus ornatus</i> (Fry)	Northeast Queensland (and New Guinea)

NAMES APPLIED TO AUSTRALIAN AMPHIBIANS

SO MANY NAMES have been used in the past for Australian frogs that it is frequently difficult to know the species to which they now apply. In an attempt to remedy this situation, a list has been prepared of all the names that I could find, and a verdict is given on their current status (table 10).

Although I have attempted to list all the names ever applied to Australian amphibians, I have not listed all the incorrect uses of these names. To have done so would have lengthened the list greatly and probably reduced its usefulness. There have been numerous instances in the past, and I am sure the present work is not free of them, of the assignment of one species erroneously to another. Thus the name "*Limnodynastes tasmaniensis*" has been

used for individuals of *Limnodynastes fletcheri*, of *Limnodynastes peroni*, and of doubtless other species. These uses are not listed.

The list in table 10 consists of the first use of every name, the type locality, and the current taxonomic allocation.

An effort has been made to ascertain the whereabouts of the type specimens of frogs described from Australia. The location of the type specimen, if known, is given in parentheses following the type locality. The abbreviations used are:

A.M., Australian Museum, Sydney
A.M.N.H., the American Museum of Natural History, New York
Amst., Zoologisch Museum, Amsterdam
Ber., Zoologisches Museum, Berlin

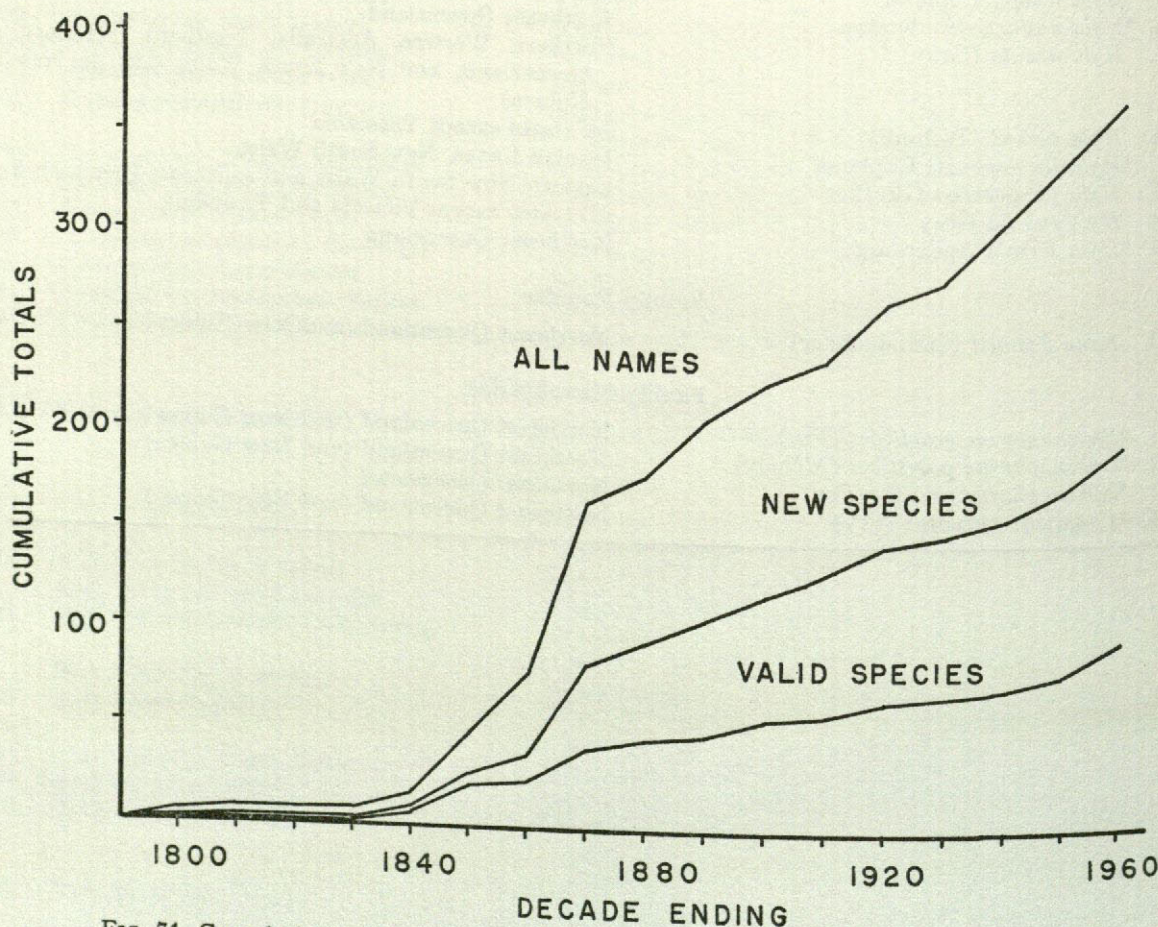


FIG. 71. Cumulative totals, by decades, of species regarded as valid, all new species, and all names applied to Australian frogs. Data from table 10.

B.M., British Museum (Natural History), London
 C., private collection of Stephen J. Copland, Sydney
 Gött., Zoologischen Museums, Göttingen
 H., holotype
 Hu., Magyar Nemzeti Museum, Budapest
 Le., Rijksmuseum van Natuurlijke Historie, Leiden
 M.A.F., Museum, Amateur Fishermen's Association of Queensland
 M.C.Z., Museum of Comparative Zoölogy, Cambridge
 N.M.V., National Museum of Victoria, Melbourne
 P., Muséum National d'Histoire Naturelle, Paris
 Q.M., Queensland Museum, Brisbane
 Q.V.M., Queen Victoria Museum, Launceston
 S., syntype

S.A., South Australian Museum, Adelaide
 Sen., Natur-Museum, Senckenberg
 St., Royal Museum of Natural History, Stockholm
 U.S.N.M., United States National Museum, Washington
 V., Naturhistorisches Museum, Vienna
 W.A., Western Australian Museum, Perth
 Z.W.A., Zoology Department, University of Western Australia, Perth

The data of table 10 have been used in the preparation of figure 71. This figure shows the progress of herpetology, as applied to Australian frogs, and it also shows something about taxonomy as well.

TABLE 10
 A LIST OF ALL NAMES APPLIED TO THE FROGS OF AUSTRALIA, THE TYPE LOCALITIES, AND THE CURRENT NAMES

Name	Type Locality	Current Name
<i>Adelotus brevis</i> Ogilby, 1907, p. 32 New name, by implication, for <i>Cryptotis brevis</i>		<i>Adelotus brevis</i> (Günther)
<i>Alytes australis</i> Gray, 1842, p. 56	North coast (=Port Essington, Northern Territory) (S.; B.M.)	<i>Cyclorana australis</i> (Gray)
<i>Auletris jacksoniensis</i> Fitzinger, 1843, p. 30 New combination for <i>Ranoides jacksoniensis</i>		<i>Hyla aurea aurea</i> (Lesson)
<i>Austrochaperina brevipes</i> Fry, 1915, p. 61	Bloomfield River, near Cooktown, Queensland	<i>Sphenophryne polysticta</i> (Méhely)
<i>Austrochaperina gracilipes</i> Fry, 1912, p. 93	Somerset, Cape York, Queensland (H.; A.M.)	<i>Sphenophryne gracilipes</i> (Fry)
<i>Austrochaperina ornata</i> Fry, 1912, p. 91	Russell River and Cairns, northeast Queensland (H.; A.M.)	<i>Cophixalus ornatus</i> (Fry)
<i>Austrochaperina robusta</i> Fry, 1912, p. 89	Russell River, northeast Queensland (H.; A.M.)	<i>Sphenophryne robusta</i> (Fry)
<i>Bombinator australis</i> Gray, 1835, p. 57	Swan River, Australia (H.; B.M.)	<i>Pseudophryne australis</i> (Gray)
<i>Breviceps gouldii</i> Gray, 1841a, p. 448; 1841b, p. 89	Western Australia (M.; B.M.)	<i>Myobatrachus gouldi</i> (Gray)
<i>Breviceps heliogabali</i> Gray, 1841a, caption pl. 1, fig. 1 ? <i>Lapsus calami</i> for <i>Breviceps gouldii</i> . See H. W. Parker, 1940, p. 92. Not so in A.M.N.H. copy		<i>Myobatrachus gouldi</i> (Gray)
<i>Bufonella crucigera</i> Keferstein, 1868a, p. 272 <i>Lapsus calami</i> for <i>Bufonella crucigera</i>		<i>Pseudophryne australis</i> (Gray)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Bufo marinus</i> Schneider, 1799, p. 219 New combination for <i>Rana marina</i>	America	<i>Bufo marinus</i> (Linnaeus)
<i>Bufoella crucifera</i> Girard, 1853, p. 424	New Holland (= Australia)	<i>Pseudophryne australis</i> (Gray)
<i>Calamita cyanea</i> Fitzinger, 1826, p. 64 New combination for <i>Hyla cyanea</i>		<i>Hyla caerulea</i> (White)
<i>Calamita dolichopsis</i> Cope, 1867, p. 204	Amboina	<i>Hyla infrafronata</i> Günther
<i>Calamites coerulea</i> Wagler, 1830, p. 200 New combination for <i>Rana caerulea</i>		<i>Hyla caerulea</i> (White)
<i>Calamites cyaneus</i> Fitzinger, 1861, p. 413 New combination for <i>Hyla cyanea</i>		<i>Hyla caerulea</i> (White)
<i>Camariolius pictus</i> Cope, 1867, p. 202 <i>Lapsus calami</i> for <i>Camariolius varius</i>		<i>Crinia signifera</i> Girard
<i>Camariolius (Pterophrynus) tasmaniensis</i> William K. Parker, 1881, p. 102 New combination for <i>Pterophrynus tasmaniensis</i>		<i>Crinia tasmaniensis</i> (Günther)
<i>Camariolius varius</i> Peters, 1863, p. 236	Adelaide, South Australia (S.; Ber.)	<i>Crinia signifera</i> Girard and possibly another species
<i>Chaperina polysticta</i> Méhely, 1901, pp. 208, 258	Sattelberg, New Guinea (H.; Hu.)	<i>Sphenophryne polysticta</i> (Méhely)
<i>Chiroleptes platycephalus</i> Spencer and Gillen, 1912, vol. 1, p. 59 <i>Lapsus calami</i> for <i>Chiroleptes platycephalus</i>		<i>Cyclorana platycephalus</i> (Günther)
<i>Chelydobatrachus gouldii</i> Günther, 1858, p. 53 New combination for <i>Breviceps gouldii</i>		<i>Myobatrachus gouldii</i> (Gray)
<i>Chirodrias raniformis</i> Keferstein, 1867, p. 358	Australia (?New South Wales)	<i>Hyla aurea raniformis</i> (Keferstein)
<i>Chiroleptes alboguttatus</i> Günther, 1867, p. 54	Port Denison (= Bowen) and Cape York, Queensland (S.; B.M.)	<i>Cyclorana alboguttatus</i> (Günther)
<i>Chiroleptes albopunctatus</i> Fletcher, 1894b, p. 525 <i>Lapsus calami</i> for <i>Chiroleptes alboguttatus</i>		<i>Cyclorana alboguttatus</i> (Günther)
<i>Chiroleptes australis</i> Günther, 1858, p. 34		<i>Cyclorana australis</i> (Gray)

TABLE 10—(Continued)

Name	Type Locality	Current Name
New combination for <i>Alytes australis</i>		
<i>Chiroleptes brevipalmatus</i> Günther, 1876, p. 47	Port Denison (= Bowen), Peak Downs, and Gayndah, Queensland (S.; B.M.)	<i>Cyclorana brevipes</i> (Peters)
<i>Chiroleptes brevipes</i> Peters, 1871, p. 648	Port Bowen, Queensland	<i>Cyclorana brevipes</i> (Peters)
<i>Chiroleptes dahlii</i> Boulenger, 1895, p. 867	Daly River, N. Australia (= Northern Territory) (S.; B.M.)	<i>Cyclorana dahli</i> (Boulenger)
<i>Chiroleptes inermis</i> Peters, 1867, p. 30	Rockhampton, Queensland (S.; A.M.N.H.; V.)	<i>Cyclorana inermis</i> (Peters)
<i>Chiroleptes platycephalus</i> Günther, 1873, p. 350	Fort Bourke, New South Wales	<i>Cyclorana platycephalus</i> (Günther)
<i>Cophixalus ornatus</i> Parker, 1934, p. 173		<i>Cophixalus ornatus</i> (Fry)
New combination for <i>Austro-chaperina ornata</i>		
<i>Crinia acutirostris</i> Andersson, 1916, p. 8	Malanda, Queensland (S.; St.)	<i>Crinia acutirostris</i> Andersson
<i>Crinia affinis</i> Günther, 1868a, p. 480		<i>Crinia georgiana</i> Tschudi
New combination for <i>Pterophrynus affinis</i>		
<i>Crinia affinis affinis</i> Loveridge, 1935, p. 26		<i>Crinia georgiana</i> Tschudi
New combination for <i>Pterophrynus affinis</i>		
<i>Crinia affinis halmaturina</i> Condon, 1941, p. 114	Flinders Chase, Kangaroo Island, South Australia (H.; S.A.)	<i>Crinia signifera</i> Girard
<i>Crinia affinis haswelli</i> Loveridge, 1935, p. 27		<i>Crinia signifera</i> Girard
Incorrect use of <i>Crinia haswelli</i>		
<i>Crinia darlingtoni</i> Loveridge, 1933a, p. 57	Queensland National Park, MacPherson Range, Queensland (H.; M.C.Z.)	<i>Crinia darlingtoni</i> Loveridge
<i>Crinia fasciata</i> Günther, 1868a, p. 478		<i>Crinia signifera</i> Girard
New combination for <i>Pterophrynus fasciatus</i>		
<i>Crinia froggatti</i> Fletcher, 1891b, p. 275	Buninyong, and Gong Gong, near Ballarat, Victoria (S.; B.M.)	<i>Crinia laevis</i> (Günther)
<i>Crinia georgiana</i> Tschudi, 1839, pp. 38, 78	King George's Sound, Western Australia (H.; P.)	<i>Crinia georgiana</i> Tschudi
<i>Crinia georgiana</i> var. <i>affinis</i> Boulenger, 1882, p. 265		<i>Crinia georgiana</i> Tschudi
New combination for <i>Pterophrynus affinis</i>		
<i>Crinia georgiana</i> var. <i>laevipes</i> Keferstein, 1867, p. 348	Sydney, New South Wales	<i>Crinia signifera</i> Girard
<i>Crinia georgiana</i> var. <i>stolata</i> Boulenger, 1882, p. 264		<i>Crinia georgiana</i> Tschudi

TABLE 10—(Continued)

Name	Type Locality	Current Name
New combination for <i>Crinia stolata</i>		
<i>Crinia georgiana</i> var. <i>varia</i> Keferstain, 1867, p. 349		<i>Crinia signifera</i> Girard
New combination for <i>Camariolius varius</i>		
<i>Crinia glauerti</i> Loveridge, 1933a, p. 57	Mundaring Weir, Western Australia (H.; M.C.Z.)	<i>Crinia glauerti</i> Loveridge
<i>Crinia haswelli</i> Fletcher, 1894a, p. 522	Jervis Bay, New South Wales (S.; A.M.)	<i>Crinia haswelli</i> Fletcher
<i>Crinia ignita</i> Cope, 1866, p. 95	Western Australia	<i>Crinia georgiana</i> Tschudi
<i>Crinia insignifera</i> Moore, 1954a, p. 71	Attadale, Western Australia (incorrectly given as Armadale) (H.; A.M.)	<i>Crinia insignifera</i> Moore
<i>Crinia laevis</i> Günther, 1868a, p. 480		<i>Crinia laevis</i> (Günther)
New combination for <i>Pterophrynus laevis</i>		
<i>Crinia laevis froggatti</i> Loveridge, 1935, p. 29		<i>Crinia laevis</i> (Günther)
New combination for <i>Crinia froggatti</i>		
<i>Crinia laevis laevis</i> H. W. Parker, 1940, p. 75		<i>Crinia laevis</i> (Günther)
New combination for <i>Pterophrynus laevis</i>		
<i>Crinia laevis victoriana</i> H. W. Parker, 1940, p. 76		<i>Crinia laevis</i> (Günther)
New combination for <i>Crinia victoriana</i>		
<i>Crinia leai</i> Fletcher, 1898, p. 677	Bridgetown and Pipe Clay Creek (near Jarrahdale), Western Australia (S.; A.M.)	<i>Crinia leai</i> Fletcher
<i>Crinia michaelsoni</i> Werner, 1914, p. 416	Donnybrook, Western Australia (S.; A.M.N.H.; V.)	<i>Crinia leai</i> Fletcher
<i>Crinia parinsignifera</i> Main, 1957a, p. 53	Kingston-on-Murray, South Australia (H.; Z.W.A.)	<i>Crinia parinsignifera</i> Main
<i>Crinia pseudinsignifera</i> Main, 1957a, p. 52	Yorkrakine Rock, 15 miles north of Tammin, Western Australia (H.; Z.W.A.)	<i>Crinia pseudinsignifera</i> Main
<i>Crinia (Ranidella) signifera</i> Girard, 1853, p. 422	Australia (southeast coast: Girard, 1858, p. 46)	<i>Crinia signifera</i> Girard
<i>Crinia rosea</i> Harrison, 1927, p. 279	Pemberton, Western Australia	<i>Crinia rosea</i> Harrison
<i>Crinia signifera</i> Cope, 1867, p. 202		<i>Crinia signifera</i> Girard
New combination for <i>Crinia (Ranidella) signifera</i>		
<i>Crinia signifera englishi</i> H. W. Parker, 1940, p. 89	Tasmania (S.; B.M.; A.M.)	<i>Crinia signifera</i> Girard
<i>Crinia signifera ignita</i> Loveridge, 1935, p. 25		<i>Crinia georgiana</i> Tschudi

TABLE 10—(Continued)

Name	Type Locality	Current Name
New combination for <i>Crinia ignita</i>		
<i>Crinia signifera montana</i> H. W. Parker, 1940, p. 90	Mt. Kosciusko, New South Wales (S.; A.M.)	<i>Crinia signifera</i> Girard
<i>Crinia signifera signifera</i> Loveridge, 1934, p. 59	Eastern and southern Australia	<i>Crinia signifera</i> Girard
New combination for <i>Crinia (Ranidella) signifera</i>		
<i>Crinia sloanei</i> Littlejohn, 1958, p. 225	Murray River near Tocumwal, New South Wales (H.; Z.W.A.)	<i>Crinia sloanei</i> Littlejohn
<i>Crinia stictiventris</i> Cope, 1867, p. 202	Australia	<i>Crinia signifera</i> Girard
<i>Crinia stolata</i> Cope, 1867, p. 201	Western Australia	<i>Crinia georgiana</i> Tschudi
<i>Crinia subinsignifera</i> Littlejohn, 1957, p. 22	Wilgarup, 7 miles north of Manjimup, Western Australia (H.; Z.W.A.)	<i>Crinia subinsignifera</i> Littlejohn
<i>Crinia tasmaniensis</i> Keferstein, 1868, p. 265		<i>Crinia tasmaniensis</i> (Günther)
New combination for <i>Pterophrynus tasmaniensis</i>		
<i>Crinia varia</i> Keferstein, 1868a, p. 264		<i>Crinia signifera</i> Girard
New combination for <i>Camarioilius varius</i>		
<i>Crinia verrucosa</i> Günther, 1868a, p. 478		<i>Crinia signifera</i> Girard
New combination for <i>Pterophrynus verrucosus</i>		
<i>Crinia victoriana</i> Boulenger, 1888, p. 142	Warragul, Victoria (H.; B.M.)	<i>Crinia laevis</i> (Günther) (Possibly valid)
<i>Cryptotis brevis</i> Günther, 1863a, p. 28	Clarence River, New South Wales (S.; B.M.)	<i>Adelotus brevis</i> (Günther)
<i>Cunia signifera</i> Ross, 1908a, p. 131		<i>Crinia signifera</i> Girard
<i>Lapsus calami</i> for <i>Crinia signifera</i>		
<i>Cyclorana alboguttatus</i> H. W. Parker, 1940, p. 20		<i>Cyclorana alboguttatus</i> (Günther)
New combination for <i>Chiroleptes alboguttatus</i>		
<i>Cyclorana australis</i> H. W. Parker, 1940, p. 18		<i>Cyclorana australis</i> (Gray)
New combination for <i>Alytes australis</i>		
<i>Cyclorana brevipes</i> H. W. Parker, 1940, p. 21		<i>Cyclorana brevipes</i> (Peters)
New combination for <i>Chiroleptes brevipes</i>		
<i>Cyclorana cultripes</i> H. W. Parker, 1940, p. 22	Alexandria, Northern Territory (H.; B.M.)	<i>Cyclorana cultripes</i> (Parker)
<i>Cyclorana dahlii</i> H. W. Parker, 1940, p. 17		<i>Cyclorana dahli</i> (Boulenger)

TABLE 10—(Continued)

Name	Type Locality	Current Name
New combination for <i>Chiro-leptes dahlui</i> <i>Cyclorana inermis</i> H. W. Parker, 1940, p. 17		<i>Cyclorana inermis</i> (Peters)
New combination for <i>Chiro-leptes inermis</i> <i>Cyclorana novae hollandiae</i> Steindachner, "1869" (1867), p. 29	Rockhampton, Queensland	<i>Cyclorana australis</i> (Gray)
<i>Cyclorana platycephalus</i> H. W. Parker, 1940, p. 22		<i>Cyclorana platycephalus</i> (Günther)
New combination for <i>Chiro-leptes platycephalus</i> <i>Cyclorana slevini</i> Loveridge, 1950, p. 131	Noondoo, southeastern Queensland (H.; A.M.)	<i>Cyclorana slevini</i> Loveridge
<i>Cystignathus dorsalis</i> Gray, 1841a, p. 446; 1841b, p. 91	Western Australia (H.; B.M.)	<i>Limnodynastes dorsalis</i> (Gray)
<i>Cystignathus georgianus</i> Duméril and Bibron, 1841, p. 416		<i>Crinia georgiana</i> Tschudi
New combination for <i>Crinia georgiana</i> <i>Cystignathus peronii</i> Duméril and Bibron, 1841, p. 409	New Holland (= Australia) (H.; P.)	<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Cystignathus sydneyensis</i> Krefft, 1864, p. 100		<i>Crinia signifera</i> Girard
<i>Nomen nudum</i> . See Günther, 1867, p. 53		
<i>Dendrohyas citropa</i> Tschudi, 1839, p. 75	Port Jackson (= Sydney, New South Wales) (H.; P.)	<i>Hyla citropa</i> (Tschudi)
<i>Dendrohyas peronii</i> Tschudi, 1839, p. 75	"Nov. Holl." (= Australia) (H.; P.)	<i>Hyla peroni</i> (Tschudi)
<i>Discoglossus ornatus</i> Gray, 1842, p. 56	Port Essington, Northern Territory (H.; B.M.)	<i>Limnodynastes ornatus</i> (Gray)
<i>Eucnemis bicolor</i> Gray, 1842, p. 57	Port Essington, Northern Territory (H.; B.M.)	<i>Hyla bicolor</i> (Gray)
<i>Euscelis lessonae</i> Fitzinger, 1861, p. 413		<i>Hyla lesueuri</i> Duméril and Bibron
New combination for <i>Hyla lesueuri</i> <i>Euscelis lesueurii</i> Fitzinger, 1843, p. 31		<i>Hyla lesueuri</i> Duméril and Bibron
New combination for <i>Hyla lesueuri</i> <i>Fanchonia elegans</i> Werner, 1893, p. 8	Tropical Africa (in error)	<i>Hyla aurea</i> (Lesson)
<i>Glauertia mjobergi</i> H. W. Parker, 1940, p. 66		<i>Glauertia mjobergi</i> (Andersson)
New combination for <i>Pseudophryne mjobergi</i> <i>Glauertia orientalis</i> H. W. Parker, 1940, p. 67	Alexandria Station (19° 08' S., 136° 43' E.), Northern Territory (H.; B.M.)	Possibly valid. Possibly <i>Glauertia russelli</i>

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Glauertia russelli</i> Loveridge, 1933b, p. 89	Gascoyne River near Landor Station, Western Australia (H.; W.A.)	<i>Glauertia russelli</i> Loveridge
<i>Heleioporus alleopunctatus</i> Krefft, 1865, p. 17 <i>Lapsus calami</i> for <i>Heleioporus</i> <i>albopunctatus</i>		<i>Heleioporus albopunctatus</i> Gray
<i>Heleioporus alboguttatus</i> Günther, 1858, p. 33 <i>Lapsus calami</i> for <i>Heleioporus</i> <i>albopunctatus</i>		<i>Heleioporus albopunctatus</i> Gray
<i>Heleioporus albo punctatus</i> Gray, 1841a, p. 477; 1841b, p. 91	Western Australia (H.; B.M.)	<i>Heleioporus albopunctatus</i> Gray
<i>Heleioporus albopunctatus</i> var. <i>pelobatoides</i> Werner, 1914, p. 418	Beverley and Broome Hill, Western Australia	<i>Neobatrachus pelobatoides</i> (Wer- ner)
<i>Heleioporus australiacus</i> H. W. Parker, 1940, p. 39 New combination for <i>Rana</i> <i>australiaca</i>		<i>Heleioporus australiacus</i> (Shaw)
<i>Heleioporus centralis</i> H. W. Parker, 1940, p. 35	100 miles east of Lake Eyre, South Australia (H.; B.M.)	<i>Neobatrachus centralis</i> (Parker)
<i>Heleioporus pelobatoides</i> Loveridge, 1935, p. 15 New combination for <i>Helei-</i> <i>oporus albopunctatus</i> var. <i>pe-</i> <i>lobatoides</i>		<i>Neobatrachus pelobatoides</i> (Wer- ner)
<i>Heleioporus pictus</i> Boulenger, 1882, p. 272 New combination for <i>Neoba-</i> <i>trachus pictus</i>		<i>Neobatrachus pictus</i> Peters
<i>Heleioporus sudelli</i> Lamb, 1911, p. 26	Warwick, Queensland (H.; Q.M.)	<i>Neobatrachus pictus</i> Peters
<i>Heleioporus wilsmorei</i> H. W. Parker, 1940, p. 36	Wirarga, northeast of Yalgoo, Murchison, Western Australia (H.; B.M.)	<i>Neobatrachus wilsmorei</i> (Parker)
<i>Heleioporus</i> <i>flavoguttatus</i> Fletcher, 1898, p. 679 New combination for <i>Philo-</i> <i>cryphus flavoguttatus</i>		See also <i>Heleioporus</i> <i>australiacus</i> (Shaw)
<i>Heleioporus inornatus</i> Lee and Main, 1954, p. 157	Beechina, Western Australia (H.; W.A.)	<i>Heleioporus inornatus</i> Lee and Main
<i>Heleioporus insularis</i> Loveridge, 1933b, p. 92	Rottneest Island, Western Aus- tralia (H.; W.A.)	<i>Heleioporus eyrei</i> (Gray)
<i>Heleioporus psammophilus</i> Lee and Main, 1954, p. 157	Beechina, Western Australia (H.; W.A.)	<i>Heleioporus psammophilus</i> Lee and Main
<i>Heliorana grayi</i> Steindachner, "1869" (1867), p. 32	New South Wales (H.; V.)	<i>Limnodynastes dorsalis</i> (Gray)
<i>Heliorana superciliaris</i> Keferstein, 1868a, p. 267 New combination for <i>Platy-</i> <i>plectrum superciliare</i>		<i>Limnodynastes dorsalis</i> (Gray)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hyla adelaidensis</i> Gray, 1841a, p. 447; 1841b, p. 90	Western Australia (S.; B.M.)	<i>Hyla adelaidensis</i> Gray
<i>Hyla affinis</i> Boulenger, 1882, p. 413 New combination for <i>Pelodytes</i> <i>affinis</i>		<i>Hyla latopalmata</i> (Günther)
<i>Hyla aurea</i> Günther, 1858, p. 114 New combination for <i>Rana</i> <i>aurea</i>		<i>Hyla aurea</i> (Lesson)
<i>Hyla aurea aurea</i> H. W. Parker, 1938, p. 304 New combination for <i>Rana</i> <i>aurea</i>		<i>Hyla aurea aurea</i> (Lesson)
<i>Hyla aurea</i> var. <i>cyclorhynchus</i> Boulenger, 1882, p. 411	Western Australia (S.; B.M.; S.; A.M.N.H.)	<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla aurea major</i> Copland, 1957, p. 79	Collins Gap, Tasmania (H.; Q.V.M.)	<i>Hyla aurea raniformis</i> (Kefer- stein)
<i>Hyla aurea raniformis</i> Parker, 1938, p. 304 New combination for <i>Chiro-</i> <i>dryas raniformis</i>		<i>Hyla aurea raniformis</i> (Kefer- stein)
<i>Hyla aurea ulongae</i> Loveridge, 1950, p. 133	Ulong, New South Wales (H.; A.M.)	Known from single specimen; status uncertain
<i>Hyla bicolor</i> van Kampen, 1906, p. 173 New combination for <i>Eucnemis</i> <i>bicolor</i>		<i>Hyla bicolor</i> (Gray)
<i>Hyla bicolor bicolor</i> Copland, 1957, p. 14 New combination for <i>Eucnemis</i> <i>bicolor</i>		<i>Hyla bicolor</i> (Gray)
<i>Hyla bicolor glauerti</i> Copland, 1957, p. 16	Colo, near Sydney, New South Wales (H.; C.)	<i>Hyla bicolor</i> (Gray)
<i>Hyla binoculara</i> Gray, 1841a, p. 447	Western Australia (S.; B.M.)	<i>Hyla adelaidensis</i> Gray
<i>Hyla bioculara</i> Gray, 1841b, p. 90	Western Australia	<i>Hyla adelaidensis</i> Gray
<i>Hyla blandsuttoni</i> Procter, 1924, p. 1128	?Queensland (type lost)	Known from a single specimen; status uncertain; said to be near <i>Hyla aurea</i>
<i>Hyla booroolongensis</i> Moore, present paper, p. 292	Guy Fawkes Creek, Ebor, New South Wales (H.; A.M.)	<i>Hyla booroolongensis</i> Moore
<i>Hyla burrowsi</i> Scott, 1942, p. 5	Cradle Valley, Tasmania (H.; Q.V.M.)	<i>Hyla burrowsi</i> Scott
<i>Hyla caerulea</i> Gray, 1842, p. 56 New combination for <i>Rana</i> <i>caerulea</i>		<i>Hyla caerulea</i> (White)
<i>Hyla caerulea gilleni</i> Copland, 1957, p. 30 New combination for <i>Hyla</i> <i>gilleni</i>		<i>Hyla caerulea</i> (White)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hyla (Calamites) cyaneus</i> Fitzinger, 1843, p. 30 New combination for <i>Calamites cyaneus</i>		<i>Hyla caerulea</i> (White)
<i>Hyla calliscelis</i> Peters, 1875, p. 620	Adelaide, South Australia (S.; Ber.)	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla castanea</i> Steindachner, "1869" (1867) p. 62	Unknown (possibly Australia)	? <i>Hyla aurea raniformis</i> (Keferstein)
<i>Hyla chloris</i> Boulenger, 1893, p. 403	Dunoon, Richmond River, New South Wales (H.; B.M.)	<i>Hyla chloris</i> Boulenger
<i>Hyla citropa</i> Duméril and Bibron, 1841, p. 600 New combination for <i>Dendrohyas citropa</i>		<i>Hyla citropa</i> (Tschudi)
<i>Hyla citropus</i> Günther, 1858, p. 115 New combination for <i>Hyla citropa</i>		<i>Hyla citropa</i> (Tschudi)
<i>Hyla cyanea</i> Daudin, 1802, p. 43		<i>Hyla caerulea</i> (White)
<i>Hyla cyclorhyncha</i> Whitley, 1947, p. 53 <i>Lapsus calami</i> for <i>Hyla cyclorhynchus</i>		<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla cyclorhynchus</i> H. W. Parker, 1938, p. 304 New combination for <i>Hyla aurea cyclorhynchus</i>		<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla dayi</i> Günther, 1897, p. 406	Bartle Frere Mountains, Queensland	<i>Hyla dayi</i> Günther
<i>Hyla dentata</i> Keferstein, 1868a, p. 284; 1868b, p. 329	New South Wales (H.; Gött.)	<i>Hyla dentata</i> Keferstein
<i>Hyla dimolops</i> Cope, 1869, p. 163 New name for <i>Litoria punctata</i>		<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla dolichopsis</i> Boulenger, 1882, p. 384 New combination for <i>Calamita dolichopsis</i>		<i>Hyla infrafronata</i> Günther
<i>Hyla (Dryopsophus) citropa</i> Fitzinger, 1843, p. 30 New combination for <i>Hyla citropa</i>		<i>Hyla citropa</i> (Tschudi)
<i>Hyla eucnemis</i> Lönnberg, 1900, p. 579	Sattleberg, New Guinea	<i>Hyla eucnemis</i> Lönnberg (probably applied incorrectly to <i>Hyla serrata</i> in Australia)
<i>Hyla ewingii</i> Duméril and Bibron, 1841, p. 597	Van Diemen's Land (= Tasmania) (H.; P.)	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii alpina</i> Fry, 1915, p. 79	Mt. Kosciusko, New South Wales (H.; A.M.)	<i>Hyla ewingi</i> Duméril and Bibron; possibly valid

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hyla ewingii calliscelis</i> Boulenger, 1882, p. 407 New combination for <i>Hyla calliscelis</i>		<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii ewingii</i> Loveridge, 1935, p. 45 New combination for <i>Hyla ewingii</i>		<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii iuxtaewingii</i> Copland, 1957, p. 60	18 miles west of Bairnsdale, Victoria (H.; C.)	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii krefftii</i> Fletcher, 1898, p. 670 New combination for <i>Hyla krefftii</i>		<i>Hyla jervisiensis</i> Duméril and Bibron
<i>Hyla ewingii loveridgei</i> Copland, 1957, p. 65	Porter's Retreat, New South Wales (H.; C.)	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii orientalis</i> Fletcher, 1898, p. 670	New South Wales	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii verauxii</i> Slevin, 1955, p. 383 <i>Lapsus calami</i> for <i>Hyla ewingii verauxii</i>		<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla ewingii verreauxii</i> Loveridge, 1935, p. 46 New combination for <i>Hyla verreauxii</i>		<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla fenestrata</i> de Vis, 1884b, p. 128	Tweed River, New South Wales	<i>Mixophyes fasciolatus</i> Günther
<i>Hyla fordii</i> Günther, 1876, p. 47	Rockhampton, Queensland (S.; B.M.)	<i>Hyla gracilentia</i> Peters
<i>Hyla freycineti</i> Boulenger, 1882, p. 414 New combination for <i>Litoria freycineti</i>		<i>Hyla freycineti</i> (Tschudi)
<i>Hyla gilleni</i> Spencer, 1896b, p. 173	Alice Springs, Northern Territory (H.; N.M.V.)	<i>Hyla caerulea</i> (White)
<i>Hyla gracilentia</i> Peters, 1869, p. 789	Port Mackay, Queensland (H.; Ber.)	<i>Hyla gracilentia</i> Peters
<i>Hyla hyposticta</i> Cope, 1866, p. 85 <i>Lapsus calami</i> for <i>Hyla hyposticta</i>		<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla infrafronata</i> Günther, 1867, p. 56	Cape York, Queensland (H.; B.M.)	<i>Hyla infrafronata</i> Günther
<i>Hyla infrataeniata</i> Boulenger, 1885, p. 387 <i>Lapsus calami</i> for <i>Hyla infrafronata</i>		<i>Hyla infrafronata</i> Günther
<i>Hyla ingrofrenata</i> Krefft, 1870, p. 748 <i>Lapsus calami</i> for <i>Hyla nigrofrenata</i>		? <i>Hyla nigrofrenata</i> Günther
<i>Hyla inguinalis</i> Ahl, 1935, p. 252	South Australia (= Adelaide?) (H.; Ber.)	<i>Hyla ewingi</i> Duméril and Bibron

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hyla irrorata</i> de Vis, 1884b, p. 128	Gympie, Queensland (type lost; Fry, 1912, p. 100)	Status uncertain; probably <i>Hyla caerulea</i> (Fry, 1912, p. 100); valid (Copland, 1957, p. 34) <i>Hyla aurea aurea</i> (Lesson)
<i>Hyla jacksoniensis</i> Duméril and Bibron, 1841, p. 602 New combination for <i>Ranoidea jacksoniensis</i>		<i>Hyla aurea aurea</i> (Lesson)
<i>Hyla jacksonii</i> Duméril and Bibron, 1854, p. 407 New combination for <i>Ranoidea jacksoniensis</i>		
<i>Hyla jenolanensis</i> Copland, 1957, p. 97	Bottomless Pit, Jenolan Cave, New South Wales (H.; A.M.)	Status uncertain; known only from the type specimen <i>Hyla jervisiensis</i> Duméril and Bibron
<i>Hyla jervisiensis</i> Werner, 1897b, p. 216 <i>Lapsus calami</i>		
<i>Hyla jervisiensis</i> Duméril and Bibron, 1841, p. 580	Jervis Bay, New South Wales (H.; P.)	<i>Hyla jervisiensis</i> Duméril and Bibron
<i>Hyla kinghorni</i> Loveridge, 1950, p. 132	Ulong, New South Wales (H.; A.M.)	Status uncertain; known only from type specimen
<i>Hyla krefftii</i> Günther, 1863a, p. 28	Sydney, New South Wales (H.; B.M.)	<i>Hyla jervisiensis</i> Duméril and Bibron <i>Hyla latopalmata</i> (Günther)
<i>Hyla latopalmata</i> Boulenger, 1882, p. 414 New combination for <i>Litoria latopalmata</i>		
<i>Hyla latopalmata watjulumensis</i> Copland, 1957, p. 96	Watjulum Mission, Western Australia (S.; A.M.)	<i>Hyla latopalmata</i> (Günther) <i>Hyla lesueuri</i> Duméril and Bibron
<i>Hyla leseurei</i> Cope, 1886, p. 84 <i>Lapsus calami</i> for <i>Hyla lesueuri</i>		
<i>Hyla lesueuri</i> Duméril and Bibron, 1841, p. 595	Port Jackson (= Sydney, New South Wales) (S.; P.)	<i>Hyla lesueuri</i> Duméril and Bibron
<i>Hyla lesueurii</i> var. <i>vinosa</i> Fry, 1915, p. 84 New combination for <i>Hyla vinosa</i>		Status uncertain; possibly valid; possibly <i>Hyla lesueuri</i> ? <i>Hyla lesueuri</i> Duméril and Bibron
<i>Hyla (Litoria?) copei</i> Keferstein, 1868a, p. 278 New combination for <i>Litoria copei</i>		<i>Hyla freycineti</i> (Tschudi)
<i>Hyla (Litoria) freycinetii</i> Keferstein, 1867, p. 355 New combination for <i>Litoria freycineti</i>		
<i>Hyla (Litoria) freycineti</i> var. <i>unicolor</i> Keferstein, 1867, p. 355	Australia	<i>Hyla lesueuri</i> Duméril and Bibron <i>Hyla freycineti</i> (Tschudi)
<i>Hyla (Litoria) freycineti</i> var. <i>verruculata</i> Keferstein, 1867, p. 355	Australia	

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hyla (Litoria) marmorata</i> Keferstein, 1868a, p. 277 New combination for <i>Litoria marmorata</i>		<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla (Litoria) mystacina</i> Keferstein, 1867, p. 356	Australia (S.; Gött.)	? <i>Hyla freycineti</i> (Tschudi)
<i>Hyla (Litoria) nasuta</i> Keferstein, 1868a, p. 277 New combination and a <i>lapsus calami</i> for <i>Pelodytes nasutus</i>		<i>Hyla nasuta</i> (Gray)
<i>Hyla (Litoria ?) punctata</i> Keferstein, 1868a, p. 277 New combination for <i>Litoria punctata</i>		<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Hyla (Litoria) wilcoxii</i> Keferstein, 1868a, p. 278 New combination for <i>Litoria wilcoxii</i>		<i>Hyla lesueuri</i> Duméril and Bibron
<i>Hyla luteiventris</i> Ogilby, 1907, p. 31	Brisbane, Queensland (H.; M.-A.F.)	<i>Hyla gracilentia</i> Peters
<i>Hyla maculata</i> Spencer, 1901, p. 177	Powong, Victoria (H.; N.M.V.)	Status uncertain; possibly <i>Hyla citropa</i>
<i>Hyla moorei</i> Copland, 1957, p. 83	Pemberton, Western Australia (H.; W.A.)	<i>Hyla moorei</i> Copland
<i>Hyla nannotis</i> Andersson, 1916, p. 16	Tully River, north Queensland (H.; St.)	Probably valid; Loveridge (1935) makes it a synonym of <i>Hyla obsoleta</i>
<i>Hyla nasuta</i> Boulenger, 1882, p. 415 New combination for <i>Pelodytes nasutus</i>		<i>Hyla nasuta</i> (Gray)
<i>Hyla nigrofrenata</i> Günther, 1867, p. 56	Cape York, Queensland (S.; B.M.)	Status uncertain; possibly valid
<i>Hyla nobilis</i> de Vis, 1884b, p. 129	Cape York, Queensland	<i>Rana daemeli</i> (Steindachner)
<i>Hyla obsoleta</i> Lönnberg, 1900, p. 580	Simbang, New Guinea	Status uncertain; used, probably incorrectly, for <i>Hyla nannotis</i> in Australia
<i>Hyla oculata</i> Péron and Lesueur, MS		<i>Hyla lesueuri</i> Duméril and Bibron
<i>Hyla palmata</i> Slevin, 1955, p. 383 <i>Lapsus calami</i> for <i>Hyla latopalmata</i>		<i>Hyla latopalmata</i> (Günther)
<i>Hyla parvidens</i> Peters, 1875, p. 620	Port Phillip, Victoria (= Melbourne) (H.; Ber.)	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla peninsulæ</i> de Vis, 1884b, p. 130	Cape York, Queensland	<i>Hyla nasuta</i> (Gray)
<i>Hyla peronii</i> Duméril and Bibron, 1841, p. 569 New combination for <i>Dendrohyas peronii</i>		<i>Hyla peroni</i> (Tschudi)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hyla perronii</i> Deckert, 1915, p. 26		<i>Hyla peroni</i> (Tschudi)
<i>Lapsus calami</i>		
<i>Hyla phyllochroa</i> Günther, 1863b, p. 251	Sydney and Errumanga, New South Wales (S.; B.M.)	<i>Hyla phyllochroa</i> Günther
<i>Hyla phyllochroa barringtonensis</i> Copland, 1957, p. 45	Cutler's Pass, Williams River, New South Wales (H; A.M.)	<i>Hyla phyllochroa</i> Günther
<i>Hyla phyllochroa phyllochroa</i> Copland, 1957, p. 43		<i>Hyla phyllochroa</i> Günther
New combination for <i>Hyla phyllochroa</i>		
<i>Hyla rothii</i> de Vis, 1884a, p. 66	Mackay, Queensland	<i>Hyla peroni</i> (Tschudi)
<i>Hyla rubella</i> Gray, 1842, p. 56	Port Essington, Northern Territory (S.; B.M.)	<i>Hyla rubella</i> Gray
<i>Hyla schuettei</i> Keferstein, 1868a, p. 279; 1868b, p. 328	Sydney, New South Wales (S.; Gött.)	<i>Hyla adelaidensis</i> Gray
<i>Hyla semoni</i> Boettger, 1894, p. 112	Southeast New Guinea (H.; Sen.)	<i>Hyla nasuta</i> (Gray)
<i>Hyla serrata</i> Andersson, 1916, p. 17	Carrington, Malanda, and Atherton, Queensland (S.; St.)	<i>Hyla serrata</i> Andersson; according to Loveridge, 1935, a synonym of <i>Hyla eucnemis</i>
<i>Hyla serveiensis</i> Krefft, 1863, p. 389		<i>Hyla jervisiensis</i> Duméril and Bibron
<i>Lapsus calami</i> for <i>Hyla jervisiensis</i>		
<i>Hyla thyposticta</i> Cope, 1869, p. 163		<i>Hyla cyclorhynchus</i> (Boulenger)
New name for <i>Litoria marmorata</i>		
<i>Hyla tornieri</i> Nieden, 1923, p. 228		<i>Hyla latopalmata</i> (Günther)
New name for <i>Hyla affinis</i>		
<i>Hyla tympanocryptis</i> Andersson, 1916, p. 19	Malanda, Queensland (H.; St.)	<i>Hyla dayi</i> Günther
<i>Hyla unguinalis</i> Condon, 1941, p. 115		<i>Hyla ewingi</i> Duméril and Bibron
<i>Lapsus calami</i> for <i>Hyla inguinalis</i>		
<i>Hyla verreauxii</i> Duméril, 1853, p. 171	Australia (S.; P.)	<i>Hyla ewingi</i> Duméril and Bibron
<i>Hyla vinosa</i> Lamb, 1911, p. 27	Ithaca Creek, Brisbane, Queensland (H.; Q.M.)	Status uncertain; possibly valid; possibly <i>Hyla lesueuri</i>
<i>Hyla X</i> Copland, 1957, p. 87		<i>Hyla booroolongensis</i> Moore
<i>Hylarana nebulosa</i> Macleay, 1877, p. 137	Cape York, Queensland (H.; Q.M.; Fry, 1913b, p. 49)	<i>Rana daemeli</i> (Steindachner)
<i>Hylella bicolor</i> Boulenger, 1882, p. 421		<i>Hyla bicolor</i> (Gray)
New combination for <i>Eucnemis bicolor</i>		

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Hylomantis fallax</i> Peters, 1881, p. 224	Port Bowen, Mackay, and Rockhampton, Queensland (S.; Ber.)	<i>Hyla bicolor</i> (Gray)
<i>Hylorana daemeli</i> Steindachner, 1868, p. 532	Cape York, Queensland (S.; V.)	<i>Rana daemeli</i> (Steindachner)
<i>Hyperolia marmorata</i> Boulenger, 1882, p. 267 New combination for <i>Uperoleia marmorata</i>		<i>Uperoleia marmorata</i> Gray
<i>Hyperolius</i> ? <i>bicolor</i> Günther, 1858, p. 89 New combination for <i>Eucnemis bicolor</i>		<i>Hyla bicolor</i> (Gray)
<i>Hyperolius</i> (<i>Uperoleia</i>) <i>marmoratus</i> Parker, 1881, p. 134 New combination for <i>Uperoleia marmoratus</i>		<i>Uperoleia marmorata</i> Gray
<i>Kyarranus loveridgei</i> Moore, 1958, p. 4 New combination for <i>Philoria loveridgei</i>		<i>Kyarranus loveridgei</i> (Parker)
<i>Kyarranus sphagnicolus</i> Moore, 1958, p. 4	Point Lookout, near Ebor, New South Wales (H.; A.M.)	<i>Kyarranus sphagnicolus</i> Moore
<i>Lechriodus fletcheri</i> Loveridge, 1935, p. 22 New combination for <i>Phanerotis fletcheri</i>		<i>Lechriodus fletcheri</i> (Boulenger)
<i>Limnodynastes affinis</i> Günther, 1863a, p. 27	Clarence River, New South Wales (H.; B.M.)	<i>Limnodynastes tasmaniensis</i> Günther
<i>Limnodynastes bibronii</i> Krefft, 1865, p. 16 ? <i>Lapsus calami</i>		? <i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dorsalis</i> Günther, 1858, p. 33 New combination for <i>Cystignathus dorsalis</i>		<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dorsalis dorsalis</i> Loveridge, 1935, p. 21 New combination for <i>Cystignathus dorsalis</i>		<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dorsalis</i> var. <i>dumerilii</i> Fry, 1913a, p. 26 New combination for <i>Limnodynastes</i> (<i>Platyplectrum</i>) <i>dumerilii</i>		<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dorsalis insularis</i> Parker, 1940, p. 47	Near Launceston, Eagle Hawk Neck, Tasmania (S.; B.M.; M.C.Z.)	<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dorsalis</i> var. <i>interioris</i> Fry, 1913a, p. 33	Mersol Creek, Riverina, New South Wales (H.; A.M.)	<i>Limnodynastes dorsalis</i> (Gray)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Limnodynastes dorsalis</i> var. <i>terrae-reginae</i> Fry, 1915, p. 67	Somerset, Cape York, Queensland (H.; A.M.)	<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dorsalis</i> var. <i>typica</i> Fry, 1913a, p. 24 New combination for <i>Cystignathus dorsalis</i>		<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes dumerilii</i> Günther, 1868a, p. 478 New combination for <i>Limnodynastes</i> (<i>Platyplectron</i>) <i>dumerilii</i>		<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes fletcheri</i> Boulenger, 1888, p. 142	Guntawang, near Mudgee, New South Wales (S.; B.M.)	<i>Limnodynastes fletcheri</i> Boulenger
<i>Limnodynastes krefftii</i> Günther, 1863a, p. 26	Sydney, New South Wales (S.; B.M.)	<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Limnodynastes lineatus</i> de Vis, 1884a, p. 65	Mackay, Queensland (S.; B.M.)	<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Limnodynastes marmoratus</i> Lamb, 1911, p. 28	Goondiwindi, Queensland (H.; Q. M.)	<i>Limnodynastes fletcheri</i> Boulenger
<i>Limnodynastes olivaceus</i> de Vis, 1884a, p. 66	Mackay, Queensland (H.; B.M.)	<i>Limnodynastes convexiusculus</i> (Macleay)
<i>Limnodynastes ornatus</i> Günther, 1858, p. 33 New combination for <i>Discoglossus ornatus</i>		<i>Limnodynastes ornatus</i> (Gray)
<i>Limnodynastes peronii</i> Fitzinger, 1843, p. 31 New combination for <i>Cystignathus peronii</i>		<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Limnodynastes peronii</i> var. <i>krefftii</i> Keferstein, 1867, p. 345 New combination for <i>Limnodynastes krefftii</i>		<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Limnodynastes peronii lineatus</i> Loveridge, 1935, p. 18 New combination for <i>Limnodynastes lineatus</i>		<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Limnodynastes peronii peronii</i> Loveridge, 1935, p. 17 New combination for <i>Cystignathus peronii</i>		<i>Limnodynastes peroni</i> (Duméril and Bibron)
<i>Limnodynastes peronii</i> var. <i>rugulosus</i> Keferstein, 1867, p. 344	Sydney, New South Wales (S.; Gött.)	<i>Limnodynastes tasmaniensis</i> Günther
<i>Limnodynastes peronii</i> var. <i>tasmaniensis</i> Keferstein, 1867, p. 344 New combination for <i>Limnodynastes tasmaniensis</i>		<i>Limnodynastes tasmaniensis</i> Günther
<i>Limnodynastes platycephalus</i> Günther, 1867, p. 54	Adelaide, South Australia (S.; B.M.)	<i>Limnodynastes tasmaniensis</i> Günther

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Limnodynastes (Platyplectron) dumerilii</i> Peters, 1863, p. 235	Adelaide, South Australia (S.; A.M.N.H.)	<i>Limnodynastes dorsalis</i> (Gray)
<i>Limnodynastes salmini</i> Steindachner, "1869" (1867), p. 27	Australia (S.; V.)	<i>Limnodynastes salmini</i> Steindachner
<i>Limnodynastes spenceri</i> H. W. Parker, 1940, p. 50	Alice Springs, Northern Territory (H.; B.M.)	Possibly valid; possibly <i>Limnodynastes ornatus</i> (Gray)
<i>Limnodynastes tasmanicus</i> McCoy, 1867, p. 182		<i>Limnodynastes tasmaniensis</i> Günther
<i>Lapsus calami</i> for <i>Limnodynastes tasmaniensis</i>		
<i>Limnodynastes tasmaniensis</i> Günther, 1858, p. 33	Tasmania and Australia (S.; B.M.)	<i>Limnodynastes tasmaniensis</i> Günther
<i>Limnodynastes tasmaniensis</i> var. <i>platycephalus</i> Waite, 1929, p. 250		<i>Limnodynastes tasmaniensis</i> Günther
New combination for <i>Limnodynastes platycephalus</i>		
<i>Litoria aurea</i> Günther, 1864a, p. 49		<i>Hyla aurea</i> (Lesson)
New combination for <i>Rana aurea</i>		
<i>Litoria copei</i> Steindachner, "1869" (1867), p. 56	New South Wales (H.; V.)	? <i>Hyla lesueuri</i> Duméril and Bibron
<i>Litoria freycineti</i> Tschudi, 1839, pp. 36, 77	Australia (S.; P.)	<i>Hyla freycineti</i> (Tschudi)
<i>Litoria jervisiensis</i> Peters, 1873b, p. 612		<i>Hyla jervisiensis</i> Duméril and Bibron
New combination for <i>Hyla jervisiensis</i>		
<i>Litoria latopalmata</i> Günther, 1867, p. 55	Port Denison, Queensland (S.; B.M.)	<i>Hyla latopalmata</i> (Günther)
<i>Litoria lesueurii</i> Peters, 1873b, p. 611		<i>Hyla lesueuri</i> Duméril and Bibron
New combination for <i>Hyla lesueuri</i>		
<i>Litoria marmorata</i> Duméril, 1853, p. 150	Australia (S.; P.)	<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Litoria nasuta</i> Günther, 1858, p. 97		<i>Hyla nasuta</i> (Gray)
New combination for <i>Pelodytes nasutus</i>		
<i>Litoria punctata</i> Duméril, 1853, p. 149	Sydney (H.; P.)	<i>Hyla cyclorhynchus</i> (Boulenger)
<i>Litoria unicolor</i> Keferstein, 1868a, p. 290		<i>Hyla lesueuri</i> Duméril and Bibron
New combination for <i>Hyla (Litoria) freycineti</i> var. <i>unicolor</i>		
<i>Litoria wilcoxii</i> Günther, 1864a, p. 48; 1864b, p. 314	Clarence River, New South Wales (S.; B.M.)	<i>Hyla lesueuri</i> Duméril and Bibron

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Limnodynastes</i>		See <i>Limnodynastes</i>
<i>Metacrinia nichollsi</i> Parker, 1940, p. 93 New combination for <i>Pseudophryne nichollsi</i>		<i>Metacrinia nichollsi</i> (Harrison)
<i>Mitrololysis alboguttatus</i> Cope, 1889, p. 312 New combination for <i>Chiroleptes alboguttatus</i>		<i>Cyclorana alboguttatus</i> (Günther)
<i>Mixophyes fasciolatus</i> Günther, 1864a, p. 46; 1864b, p. 312	Clarence River, New South Wales (S.; B.M.)	<i>Mixophyes fasciolatus</i> Günther
<i>Mixophyes fasciolatus fasciolatus</i> Loveridge, 1935, p. 10 New combination for <i>Mixophyes fasciolatus</i>		<i>Mixophyes fasciolatus</i> Günther
<i>Mixophyes fasciolatus schevilli</i> Loveridge, 1933a, p. 55	Milla Milla, Queensland (H.; M.C.Z.)	<i>Mixophyes fasciolatus</i> Günther
<i>Myobatrachus paradoxus</i> Schlegel, 1858, pp. 59, 545 New combination for <i>Myobatrachus paradoxus</i>		<i>Myobatrachus gouldi</i> (Gray)
<i>Myobatrachus gouldii</i> Gray, 1850, p. 10 New combination for <i>Breviceps gouldi</i>		<i>Myobatrachus gouldi</i> (Gray)
<i>Myobatrachus paradoxus</i> Schlegel, 1850, p. 10	Swan River, Western Australia (H.; Le.)	<i>Myobatrachus gouldi</i> (Gray)
<i>Myxophyes fasciolatus</i> Krefft, 1865, p. 16 <i>Lapsus calami</i> for <i>Mixophyes fasciolatus</i>		<i>Mixophyes fasciolatus</i> Günther
<i>Neobatrachus centralis</i> Main, 1957b, p. 23 New combination for <i>Heleioporus centralis</i>		<i>Neobatrachus centralis</i> (Parker)
<i>Neobatrachus fictus</i> Krefft, 1865, p. 17 <i>Lapsus calami</i> for <i>Neobatrachus pictus</i>		<i>Neobatrachus pictus</i> Peters
<i>Neobatrachus pelobatoides</i> Main, 1957b, p. 23 New combination for <i>Heleioporus albopunctatus</i> var. <i>pelobatoides</i>		<i>Neobatrachus pelobatoides</i> (Werner)
<i>Neobatrachus pictus</i> Peters, 1863, p. 235	Adelaide, South Australia (S.; Ber.)	<i>Neobatrachus pictus</i> Peters
<i>Neobatrachus sutor</i> Main, 1957b, p. 24	Gnoolowa Hill, 18 miles north of Mingenew, Western Australia (H.; Z.W.A.)	<i>Neobatrachus sutor</i> Main
<i>Neobatrachus wilsmorei</i> Main, 1957b, p. 23 New combination for <i>Heleioporus wilsmorei</i>		<i>Neobatrachus wilsmorei</i> (Parker)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Notaden bennettii</i> Günther, 1873, p. 350	Castlereagh River, New South Wales (S.; B.M.)	<i>Notaden bennettii</i> Günther
<i>Notaden nichollsi</i> H. W. Parker, 1940, p. 63	Roebuck Bay, Western Australia (H.; B.M.)	<i>Notaden nichollsi</i> Parker
<i>Opisthodon frauenfeldi</i> Steindachner, "1869" (1867), p. 9	New South Wales (S.; V.)	<i>Limnodynastes ornatus</i> (Gray)
<i>Pachybatrachus petersii</i> Keferstein, 1868a, p. 274; 1868b, p. 326	New South Wales (presumably in error)	<i>Uperodon systoma</i> (Schneider), an Indian species
<i>Pelobius freycineti</i> Fitzinger, 1843, p. 31 New combination for <i>Litoria freycineti</i>		<i>Hyla freycineti</i> (Tschudi)
<i>Pelodryas caerulea</i> Boettger, 1901, p. 327 New combination for <i>Rana caerulea</i>		<i>Hyla caerulea</i> (White)
<i>Pelodryas caeruleus</i> Günther, 1858, p. 119 New combination for <i>Rana caerulea</i>		<i>Hyla caerulea</i> (White)
<i>Pelodryas coeruleus</i> Günther, 1863b, p. 249 New combination for <i>Rana caerulea</i>		<i>Hyla caerulea</i> (White)
<i>Pelodryas granulata</i> Peters, 1873a, p. 417	Port Bowen, Queensland (S.; Ber.)	? <i>Hyla gracilentia</i> Peters; see Boulenger, 1882, p. 383
<i>Pelodytes affinis</i> Gray, 1842, p. 56	Port Essington, Northern Territory (H.; B.M.)	<i>Hyla latopalmata</i> (Günther)
<i>Pelodytes nasutus</i> Gray, 1842, p. 56	Port Essington, Northern Territory (H.; B.M.)	<i>Hyla nasuta</i> (Gray)
<i>Pelotryas coeruleus</i> Fisher, 1883, p. 21 <i>Lapsus calami</i> for <i>Pelodryas caeruleus</i>		<i>Hyla caerulea</i> (White)
<i>Perialia eyrei</i> Gray, 1845, p. 407	Murray River (in error: probably in Western Australia according to Parker, 1940, p. 40) (S.; B.M.)	<i>Heleioporus eyrei</i> (Gray)
<i>Perialia ? ornata</i> Gray, 1845, p. 407 New combination for <i>Disco-glossus ornatus</i>		<i>Limnodynastes ornatus</i> (Gray)
<i>Phanerotis fletcheri</i> Boulenger, 1890, p. 594	Dunoon, Richmond River, New South Wales (H.; B.M.)	<i>Lechriodus fletcheri</i> (Boulenger)
<i>Phanerotis novae-guinea</i> van Kampen, 1909, p. 36	Merauke, Netherlands New Guinea (S.; Amst.)	<i>Limnodynastes convexiusculus</i> (Macleay)
<i>Philocryphus australiacus</i> Fry, 1915, p. 70 New combination for <i>Rana australiaca</i>		<i>Heleioporus australiacus</i> (Shaw)
<i>Philocryphus flavoguttatus</i> Fletcher, 1894c, p. 233	Mt. Victoria, Blue Mountains, New South Wales	<i>Heleioporus australiacus</i> (Shaw)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Philoria frosti</i> Spencer, 1901, p. 176	Mt. Baw Baw, Victoria (H.; N.M.V.)	<i>Philoria frosti</i> Spencer
<i>Philoria loveridgei</i> H. W. Parker, 1940, p. 60	Macpherson Range, southern Queensland (H.; B.M.)	<i>Kyarranus loveridgei</i> (Parker)
<i>Phractops alutaceus</i> Peters, 1867, p. 31	Rockhampton, Queensland (S.; Le.; A.M.N.H.)	<i>Cyclorana australis</i> (Gray)
<i>Phractops australis</i> Fry, 1914, p. 204 New name for <i>Alytes australis</i>		<i>Cyclorana australis</i> (Gray)
<i>Phractops brevipalmatus</i> Fry, 1915, p. 70 New combination for <i>Chiroleptes brevipalmatus</i>		<i>Cyclorana brevipes</i> (Peters)
<i>Phractops brevipes</i> Nieden, 1923, p. 523 New combination for <i>Chiroleptes brevipes</i>		<i>Cyclorana brevipes</i> (Peters)
<i>Phractops dahlui</i> Nieden, 1923, p. 522 New combination for <i>Chiroleptes dahlui</i>		<i>Cyclorana dahlui</i> (Boulenger)
<i>Phractops inermis</i> Nieden, 1923, p. 524 New combination for <i>Chiroleptes inermis</i>		<i>Cyclorana inermis</i> (Peters)
<i>Phractops platycephalus</i> Nieden, 1923, p. 520 New combination for <i>Chiroleptes platycephalus</i>		<i>Cyclorana platycephalus</i> (Günther)
<i>Phreniscus australis</i> Gray, 1841a, p. 436 New combination for <i>Bombinator australis</i>		<i>Pseudophryne australis</i> (Gray)
<i>Phryniscus albifrons</i> Duméril and Bibron, 1854, p. 413	None given	<i>Pseudophryne australis</i> (Gray)
<i>Phryniscus australis</i> Duméril and Bibron, 1841, p. 725		<i>Pseudophryne bibroni</i> and <i>Pseudophryne semimarmorata</i> (see H. W. Parker, 1940, p. 104)
<i>Phryniscus australis</i> Gray, 1845, p. 407 New combination for <i>Bombinator australis</i>		<i>Pseudophryne australis</i> (Gray)
<i>Phrynxalus reginae</i> Andersson, 1916, p. 4	Malanda and Cedar Creek, northeast Queensland (S.; St.; B.M.)	<i>Cophixalus ornatus</i> (Fry)
<i>Phrynomantis ornata</i> Loveridge, 1935, p. 55 New combination for <i>Austrochaperina ornata</i>		<i>Cophixalus ornatus</i> (Fry)
<i>Platyplectrum dorsalis</i> Günther, 1876, p. 47 New combination for <i>Cystignathus dorsalis</i>		<i>Limnodynastes dorsalis</i> (Gray)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Platyplectrum dumerilii</i> Keferstein, 1868a, p. 262 New combination for <i>Limnodynastes</i> (<i>Platyplectron</i>) <i>dumerilii</i>		<i>Limnodynastes dorsalis</i> (Gray)
<i>Platyplectrum marmoratum</i> Günther, 1863a, p. 27	Clarence River, New South Wales (H.; B.M.)	<i>Limnodynastes ornatus</i> (Gray)
<i>Platyplectrum occidentale</i> Cope, 1866, p. 90	Western Australia	? <i>Limnodynastes ornatus</i> (Gray)
<i>Platyplectrum ornatum</i> Keferstein, 1867, p. 346 New combination for <i>Disco-</i> <i>glossus ornatum</i>		<i>Limnodynastes ornatum</i> (Gray)
<i>Platyplectrum superciliare</i> Keferstein, 1867, p. 267	Australia (S.; Gött.)	<i>Limnodynastes dorsalis</i> (Gray)
<i>Pseudophryne albifrons</i> Loveridge, 1935, p. 32 New combination for <i>Phrynis-</i> <i>cus albifrons</i>		<i>Pseudophryne australis</i> (Gray)
<i>Pseudophryne australis</i> Günther, 1858, p. 45 New combination for <i>Bombina-</i> <i>tor australis</i>		<i>Pseudophryne australis</i> (Gray)
<i>Pseudophryne australis</i> forma <i>bi-</i> <i>bronii</i> Andersson, 1916, p. 12 New combination for <i>Pseudo-</i> <i>phryne bibroni</i>		<i>Pseudophryne bibroni</i> Günther
<i>Pseudophryne bibrenii</i> Krefft, 1864, p. 101 <i>Lapsus calami</i> for <i>Pseudo-</i> <i>phryne bibroni</i>		<i>Pseudophryne bibroni</i> Günther
<i>Pseudophryne bibronii</i> Günther, 1858, p. 46	Australia and Van Diemen's Land (= Tasmania) (S.; B.M.)	<i>Pseudophryne bibroni</i> Günther and <i>Pseudophryne guentheri</i> Boulenger (see H. W. Parker, 1940, p. 104)
<i>Pseudophryne bibronii</i> var. <i>semi-</i> <i>marmorata</i> Fletcher, 1898, p. 665 New combination for <i>Pseudo-</i> <i>phryne semimarmorata</i>		<i>Pseudophryne semimarmorata</i> Lucas
<i>Pseudophryne blanchardi</i> Loveridge, 1933b, p. 91	Millgrove, Victoria (H.; M.C.Z.)	<i>Pseudophryne semimarmorata</i> Lucas
<i>Pseudophryne brooksi</i> Loveridge, 1933a, p. 59	Manjimup, near Pemberton, Western Australia (H.; M.C.Z.)	<i>Pseudophryne guentheri</i> Bou- lenger
<i>Pseudophryne coriacea</i> Keferstein, 1868a, p. 272; 1868b, p. 326	Clarence River, New South Wales (S.; M.C.Z.; Gött.)	<i>Pseudophryne coriacea</i> Keferstein
<i>Pseudophryne corrobororee</i> Moore, 1953, p. 179	Round Mountain, New South Wales (H.; A.M.)	<i>Pseudophryne corrobororee</i> Moore
<i>Pseudophryne dendyi</i> Lucas, 1892, p. 62	Wellington River, North Gipps- land, Victoria (type lost; Har- rison, 1927, p. 268)	<i>Pseudophryne dendyi</i> Lucas

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Pseudophryne fimbrianus</i> H. W. Parker, 1926, p. 699	St. George District, Queensland (H.; B.M.)	<i>Uperoleia marmorata</i> Gray
<i>Pseudophryne guentheri</i> Boulenger, 1882, p. 279	Swan River, northwest Australia, and Australia (S.; B.M.)	<i>Pseudophryne guentheri</i> Boulenger
<i>Pseudophryne major</i> H. W. Parker, 1940, p. 98	Gayndah, Queensland (H.; B.M.)	<i>Pseudophryne major</i> Parker
<i>Pseudophryne mjobergii</i> Andersson, 1913a, p. 19	Noonkambah, Kimberley Division, Western Australia (S.; St.)	<i>Glauertia mjobergi</i> (Andersson)
<i>Pseudophryne nichollsi</i> Harrison, 1927, p. 284	Pemberton, Western Australia	<i>Metacrinia nichollsi</i> (Harrison)
<i>Pseudophryne occidentalis</i> H. W. Parker, 1940, p. 97	Bruce Rock, Western Australia (H.; B.M.)	<i>Pseudophryne occidentalis</i> Parker
<i>Pseudophryne rugosa</i> Andersson, 1916, p. 13	Colosseum, Queensland (S.; St.)	<i>Uperoleia marmorata</i> Gray
<i>Pseudophryne semi-marmorata</i> Lucas, 1892, p. 63	"S.E. parts of the colony, south of the Divide," Victoria (S.; N.M.V.)	<i>Pseudophryne semimarmorata</i> Lucas
<i>Pterophryne fasciata</i> Günther, 1867, p. 53 New combination for <i>Pterophrynus fasciatus</i>		<i>Crinia signifera</i> Girard
<i>Pterophryne georgiana</i> Günther, 1867, p. 53 New combination for <i>Crinia georgiana</i>		<i>Crinia georgiana</i> Tschudi
<i>Pterophrynus affinis</i> Günther, 1864a, p. 47; 1864b, p. 212	Western Australia (H.; B.M.)	<i>Crinia georgiana</i> Tschudi
<i>Pterophrynus fasciatus</i> Steindachner, "1869" (1867), p. 31	New South Wales	<i>Crinia signifera</i> Girard
<i>Pterophrynus laevis</i> Günther, 1864a, p. 48; 1864b, p. 314	Tasmania (H.; B.M.)	<i>Crinia laevis</i> (Günther)
<i>Pterophrynus tasmaniensis</i> Günther, 1864a, p. 48; 1864b, p. 313	Van Diemen's Land (= Tasmania) (S.; B.M.)	<i>Crinia tasmaniensis</i> (Günther)
<i>Pterophrynus varius</i> Steindachner, 1869, p. 31 New combination for <i>Camariolius varius</i>		<i>Crinia signifera</i> Girard
<i>Pterophrynus verrucosus</i> Lütken, 1863, p. 302	Australia	<i>Crinia signifera</i> Girard
<i>Pterophrynus varius</i> Krefft, 1867, p. 107 <i>Lapsus calami</i> for <i>Pterophrynus varius</i>		<i>Crinia signifera</i> Girard
<i>Rana aurea</i> Lesson, 1830, p. 60	Macquarie River at Bathurst, New South Wales	<i>Hyla aurea aurea</i> (Lesson)
<i>Rana australiaca</i> Shaw, 1795, pl. 200	New Holland	<i>Heleioporus australiacus</i> (Shaw)

TABLE 10—(Continued)

Name	Type Locality	Current Name
<i>Rana austrasiae</i> Schneider, 1799, p. 150 New name for <i>Rana caerulea</i>		<i>Hyla caerulea</i> (White)
<i>Rana caerulea</i> White, 1790, appendix, p. 248	? New South Wales	<i>Hyla caerulea</i> (White)
<i>Rana daemeli</i> Garman, 1901, p. 14 New combination for <i>Hylorana daemeli</i>		<i>Rana daemeli</i> (Steindachner)
<i>Rana grisea</i> van Kampen, 1913, p. 460	Went Mountains, Netherlands New Guinea	<i>Rana daemeli</i> (Steindachner), when applied to Australian specimens
<i>Rana papua</i> Lesson, 1830, p. 59	Waigiou Island, New Guinea	<i>Rana daemeli</i> (Steindachner), when applied to Australian specimens
<i>Rana spinipes</i> Schneider, 1799, pp. 129, 139	Australia	<i>Heleioporus australiacus</i> (Shaw)
<i>Ranaster convexiusculus</i> Macleay, 1877, p. 136	Katow (= Binaturi River, near Daru, Papua) (H.; Q.M.; Fry, 1913b, p. 47)	<i>Limnodynastes convexiusculus</i> (Macleay)
<i>Ranaster fletcheri</i> Nieden, 1923, p. 536 New combination for <i>Phanerotis fletcheri</i>		<i>Lechriodus fletcheri</i> (Boulenger)
<i>Ranhyla aurea</i> McCoy, 1867, p. 182 New combination for <i>Rana aurea</i>		<i>Hyla aurea</i> (Lesson)
<i>Ranidella signifera</i> Girard, 1858, p. 44 New combination for <i>Crinia</i> (<i>Ranidella</i>) <i>signifera</i>		<i>Crinia signifera</i> Girard
<i>Ranoidea aurea</i> Girard, 1858, p. 48 New combination for <i>Rana aurea</i>		<i>Hyla aurea</i> (Lesson)
<i>Ranoidea flavoviridis</i> Girard, 1853, p. 422	Wollongong, Illawara, New South Wales (S.; U.S.N.M.)	<i>Hyla lesueurii</i> Duméril and Bibron
<i>Ranoidea resplendens</i> Girard, 1853, p. 422	Wollongong, Illawara, New South Wales (H.; U.S.N.M.)	<i>Hyla aurea aurea</i> (Lesson)
<i>Ranoidea jacksoniensis</i> (also <i>Ra-</i> <i>noides</i>) Tschudi, 1839, pp. 35, 76	Port Jackson (= Sydney, New South Wales) (H.; P.)	<i>Hyla aurea aurea</i> (Lesson)
<i>Rappia</i> (<i>Hyperolius</i>) <i>bicolor</i> William K. Parker, 1881, p. 158 New combination for <i>Eucnemis bicolor</i>		<i>Hyla bicolor</i> (Gray)
<i>Sphenophryne gracilipes</i> H. W. Parker, 1934, p. 155 New combination for <i>Austro-</i> <i>chaperina gracilipes</i>		<i>Sphenophryne gracilipes</i> (Fry)
<i>Sphenophryne polysticta</i> H. W. Parker, 1934, p. 157		<i>Sphenophryne polysticta</i> (Méhely)

TABLE 10—(Continued)

Name	Type Locality	Current Name
New combination for <i>Chaperina polysticta</i>		
<i>Sphenophryne robusta</i> Nieden, 1926, p. 48		<i>Sphenophryne robusta</i> (Fry)
New combination for <i>Austro-chaperina robusta</i>		
<i>Uperoleia marmorata</i> Gray, 1841a, p. 448; 1841b, p. 90	Western Australia (H.; B.M.)	<i>Uperoleia marmorata</i> Gray
<i>Uperoleia marmorata</i> var. <i>laevigata</i> Keferstein, 1867, p. 349	Raudewick (= Randwick), New South Wales	<i>Uperoleia marmorata</i> Gray
<i>Uperoleia marmorata rugosa</i> Loveridge, 1935, p. 31		<i>Uperoleia marmorata</i> Gray
New combination for <i>Pseudophryne rugosa</i>		
<i>Uperoleia rugosa</i> H. W. Parker, 1940, p. 70		<i>Uperoleia marmorata</i> Gray
New combination for <i>Pseudophryne rugosa</i>		
<i>Wagleria dorsalis</i> Girard, 1853, p. 421		<i>Limnodynastes dorsalis</i> (Gray)
New combination for <i>Cystignathus dorsalis</i>		
<i>Wagleria peronii</i> Girard, 1853, p. 421		? <i>Limnodynastes tasmaniensis</i> Günther
New combination, possibly in error, for <i>Cystignathus peronii</i>		

GEOGRAPHIC DISTRIBUTION

IT IS CONVENIENT to consider the geographic distribution of Australian frogs from two points of view—geography and the frogs. First, lists of the species found in each state are given, and, second, the patterns of distribution that are shown by different species and groups of species are considered. In the lists that follow, only those species that are considered valid (see the synoptic list, table 9) are included.

FROGS OF THE SYDNEY REGION

Many years ago Fletcher (1890) listed 20 species that were known from Cumberland County. An even earlier list is that of Krefft (1863). There have been no additional lists.

The 27 species that occur within a 50-mile radius of Sydney are listed below. They are nearly equally divided between hylids and leptodactylids. Several other species, such as *Neobatrachus pictus* and *Limnodynastes fletcheri*, should be looked for at the extreme western limit of the area.

Mixophyes fasciolatus
Lechriodus fletcheri
Adelotus brevis
Heleioporus australiacus
Limnodynastes dorsalis
Limnodynastes peroni
Limnodynastes tasmaniensis
Uperoleia marmorata
Crinia haswelli
Crinia signifera
Pseudophryne australis
Pseudophryne bibroni
Pseudophryne coriacea
Hyla bicolor
Hyla phyllochroa
Hyla caerulea
Hyla chloris
Hyla peroni
Hyla citropa
Hyla dentata
Hyla jervisiensis
Hyla ewingi
Hyla booroolongensis
Hyla lesueuri
Hyla latopalmata
Hyla freycineti
Hyla aurea aurea

FROGS OF NEW SOUTH WALES

The state of New South Wales has many types of environment not present in the

Sydney area, such as the arid interior, the more tropical north coast, and the alpine zone of the Mt. Kosciusko Range. It is no surprising, therefore, that many additional species, not known for the Sydney area, occur within its boundaries. The papers of Fletcher (1889, 1890, 1891a, 1892, and 1894b) are especially important for an understanding of the distribution of New South Wales frogs.

Species known from southeast Queensland, such as *Cyclorana slevini*, *Kyarranus love-ridgei*, *Crinia darlingtoni*, *Pseudophryne major*, and the introduced toad, *Bufo marinus*, should be looked for in northeast New South Wales. Probably *Crinia laevis* and *Pseudophryne semimarmorata* could be added to the list by intensive collecting along the southeast border of the state.

The 43 known species of frogs of New South Wales are:

Mixophyes fasciolatus
Cyclorana alboguttatus
Cyclorana cultripes
Cyclorana platycephalus
Lechriodus fletcheri
Adelotus brevis
Neobatrachus pictus
Limnodynastes dorsalis
Limnodynastes fletcheri
Limnodynastes ornatus
Limnodynastes peroni
Limnodynastes salmini
Limnodynastes tasmaniensis
Kyarranus sphagnicolus
Notaden bennetti
Uperoleia marmorata
Crinia haswelli
Crinia parinsignifera
Crinia signifera
Crinia sloanei
Pseudophryne australis
Pseudophryne bibroni
Pseudophryne coriacea
Pseudophryne corroboree
Pseudophryne dendyi
Hyla aurea aurea
Hyla aurea raniformis
Hyla bicolor
Hyla booroolongensis
Hyla caerulea
Hyla chloris
Hyla citropa
Hyla dentata
Hyla ewingi

Hyla freycineti
Hyla gracilentia
Hyla jervisiensis
Hyla latopalmata
Hyla lesueuri
Hyla nasuta
Hyla peroni
Hyla phyllochroa
Hyla rubella

FROGS OF QUEENSLAND

This state has a greater range of environments than any other. It has deserts and rain forests and temperate and tropical climates. The state has more species of frogs than any other. Forty-seven are known (as listed below), and more are certain to be added, because the state has not been extensively studied. The most useful references are Boettger's (1894) list for the Burnett River district, Andersson's (1913a, 1916) general accounts, and Roth's (1908) list for Mackay.

Mixophyes fasciolatus
Cyclorana alboguttatus
Cyclorana australis
Cyclorana brevipes
Cyclorana inermis
Cyclorana slevini
Lechriodus fletcheri
Adelotus brevis
Neobatrachus pictus
Limnodynastes convexiusculus
Limnodynastes dorsalis
Limnodynastes fletcheri
Limnodynastes ornatus
Limnodynastes peroni
Limnodynastes salmini
Limnodynastes tasmaniensis
Kyarranus loveridgei
Notaden bennetti
Uperoleia marmorata
Crinia acutirostris
Crinia darlingtoni
Crinia signifera
Pseudophryne bibroni
Pseudophryne coriacea
Pseudophryne major
Bufo marinus (introduced)
Hyla bicolor
Hyla caerulea
Hyla chloris
Hyla dayi
Hyla ewingi
Hyla freycineti
Hyla gracilentia
Hyla infrafronata
Hyla latopalmata

Hyla lesueuri
Hyla nannotis
Hyla nasuta
Hyla peroni
Hyla phyllochroa
Hyla rubella
Hyla serrata
Rana daemeli
Sphenophryne gracilipes
Sphenophryne robusta
Sphenophryne polysticta
Cophixalus ornatus

FROGS OF THE NORTHERN TERRITORY

There are records of the occurrence of 20, or possibly 21, species in the Territory, as listed below. Very little has been published concerning its frogs apart from Spencer's (1896b) and Sternfeld's (1925) account of the centralian species, Fletcher's (1898) tabulation compiled from the literature, Kinghorn's (1931 and 1945) lists for Groote Eylandt and the Simpson Desert, Loveridge's (1938, 1949) lists for the Macdonnell Ranges and Northern Territory, and Mitchell's (1955) report on the Arnhem Land expedition material. The last author lists *Hyla adelaidensis*, which had been reported for the Northern Territory long ago but has always been questioned.

Cyclorana alboguttatus
Cyclorana australis
Cyclorana cultripes
Cyclorana dahl
Cyclorana platycephalus
Neobatrachus centralis
?Limnodynastes dorsalis
Limnodynastes ornatus
Limnodynastes convexiusculus
Glauertia orientalis (or *russelli*)
Uperoleia marmorata
Crinia signifera
Hyla adelaidensis
Hyla aurea raniformis
Hyla bicolor
Hyla caerulea
Hyla latopalmata
Hyla nasuta
Hyla nigrofrenata (or *lesueuri*)
Hyla peroni
Hyla rubella

FROGS OF VICTORIA

Little work has been done on the frogs of this state. The species known at the turn of the century are mentioned in the papers of

Lucas (1892 and 1897). The list for the 19 species known at the present time is given below. Intensive collecting should increase the total number, but the fact remains that Victoria has a poor assemblage of frogs compared to New South Wales. Thus the entire state has a smaller number of species than is known from the vicinity of Sydney alone.

Adelotus brevis
Neobatrachus pictus
Limnodynastes dorsalis
Limnodynastes peroni
Limnodynastes tasmaniensis
Philoria frosti
Crinia haswelli
Crinia laevis
Crinia parinsignifera
Crinia signifera
Crinia sloanei
Pseudophryne bibroni
Pseudophryne dendyi
Pseudophryne semimarmorata
Hyla aurea raniformis
Hyla citropa
Hyla ewingi
Hyla lesueuri
Hyla peroni

FROGS OF TASMANIA

The island of Tasmania has fewer species of frogs, and more papers listing them, than any state of Australia. General lists or accounts are given by Krefft (1869), Spencer (1892), Lucas (1897), Fletcher (1898), English (1910), Lord and Scott (1924), Blanchard (1929), Loveridge (1934), and Scott (1942). My list of the 11 species is as follows:

Limnodynastes dorsalis
Limnodynastes peroni
Limnodynastes tasmaniensis
Crinia laevis
Crinia signifera
Crinia tasmaniensis
Pseudophryne bibroni
Pseudophryne semimarmorata
Hyla aurea raniformis
Hyla burrowsi
Hyla ewingi

FROGS OF SOUTH AUSTRALIA

This is the only state to have a monograph on its herpetological fauna (Waite, 1929). Condon (1941) discusses the species of Kangaroo Island. The current state list of 13 species is given below. The number of species

is very small, as is also the case for Victoria and Tasmania. The frog fauna is quite poor in southeastern Australia.

Cyclorana platycephalus
Neobatrachus pictus
Neobatrachus centralis
Limnodynastes dorsalis
Limnodynastes ornatus
Limnodynastes tasmaniensis
Crinia parinsignifera
Crinia signifera
Pseudophryne bibroni
Hyla aurea raniformis
Hyla ewingi
Hyla peroni
Hyla rubella

FROGS OF WESTERN AUSTRALIA

This state, occupying nearly half of the continent, has a rich frog fauna, with much endemism in the southwest corner. The climate varies from tropical to temperate, and both deserts and regions of high rainfall are to be found. There is a great difference between the frogs of the wetter southwest corner and those of the drier areas of the northwest and the interior. In the list below of the 39 species of frogs in Western Australia, an N or an S appended to the name of species indicates the predominant occurrence in the northern or in the southern part of the state. The latitude of the Murchison River is used roughly as the dividing line. The most useful papers on the frogs are by Fletcher (1898), Andersson (1913a), Werner (1914), Fry (1914), Harrison (1927), Glauert (1929, 1945), Taylor (1935), Main (1954a), and Main and Calaby (1957).

Cyclorana australis (N)
Cyclorana cultripes (N)
Cyclorana platycephalus (N)
Neobatrachus centralis (N and S)
Neobatrachus pelobatoides (S)
Neobatrachus sutor (S)
Neobatrachus wilsmorei (S)
Heleioporus albopunctatus (S)
Heleioporus australiacus (S)
Heleioporus eyeri (S)
Heleioporus inornatus (S)
Heleioporus psammophilus (S)
Limnodynastes dorsalis (S)
Limnodynastes ornatus (N)
Notaden nichollsi (N)
Glauertia mjobergi (N)
Glauertia russelli (N)
Uperoleia marmorata (N)

Crinia georgiana (S)
Crinia glauerti (S)
Crinia insignifera (S)
Crinia leai (S)
Crinia pseudinsignifera (S)
Crinia rosea (S)
Crinia signifera (N)
Crinia subinsignifera (S)
Myobatrachus gouldi (S)
Metacrinia nichollsi (S)
Pseudophryne guentheri (S)
Pseudophryne occidentalis (S)
Hyla adelaidensis (S)
Hyla bicolor (N)
Hyla caerulea (N)
Hyla cyclorhynchus (S)
Hyla latopalmata (N)
Hyla moorei (S)
Hyla nasuta (N)
Hyla peroni (N)
Hyla rubella (N)

PATTERNS OF DISTRIBUTION

It is generally believed, and is possibly true, that speciation in terrestrial vertebrates involves adaptation of spatially isolated or semi-isolated populations to rather specific ecological niches. In a sense, then, we should expect nearly every species to have a unique pattern of distribution, as presumably no two niches would be exactly the same. In regions of the earth where there are abrupt changes in environmental conditions, such as the junction of a plain with a high mountain range, or of the land with the sea, the boundaries of many different ecological niches may be in nearly the same place. Where such is the case, the distribution of all the organisms restricted to these separate niches will be similar. The fact that so many species show similar patterns of distribution allows us to recognize distinct zoogeographical provinces.

Australia probably has the most uniform environment and topography of any continent. It is roughly rectangular, and there are no deep indentations of the sea. There are no mountain ranges that, on the basis of height or ruggedness alone, present much of an obstacle to the dispersal of frogs. The temperatures are moderate, and over most of the continent frost is unknown or very infrequent. If temperature were the only limiting factor, frogs could be active throughout the year in nearly every part of the continent.

As far as the past history of Australia is

concerned, the geological events that could have influenced the distribution of frogs have been minimal. During the Permian extensive glaciations influenced all parts of the continent, but this was before there were any frogs. For a short time during the Cretaceous, the eastern and western parts of the continent were separated by incursions of the sea. There has been ample time, however, for any effects that such a separation could have had on distribution to have been obliterated. No important mountain-forming periods have occurred since the beginning of the Mesozoic. The Great Dividing Range of eastern Australia was formed at the end of the Mesozoic, but it is not a formidable barrier.

The environmental variable most important in influencing the distribution of Australian frogs, both now and in the past, is water. Australia is certainly not uniform in this respect, nor was it during the recent past. About one-third of the continent receives less than 10 inches of rainfall a year, but some small areas receive more than 100 inches. Over much of Australia, and especially in the drier parts where it is most needed, the rainfall is unreliable in the sense that it varies considerably from year to year. Serious droughts in these areas are frequent, and frogs that are unable to estivate are exterminated.

Not only are there marked differences from region to region in the amount of water available, but in the past there were fluctuations of considerable magnitude. There is evidence of alternating wet and dry periods during the Pleistocene. Subsequently there was a period of extreme aridity that must have been of great importance for many species. Its effects seem to be reflected in some of the present distributions.

If temperature and moisture are the most important factors influencing the distribution of Australian frogs, and if temperature does not vary enough to be of great importance, we are left with moisture as the single variable exerting the greatest effect. Such reasoning is borne out by the facts of distribution. Sixty-three of the 94 forms, or 67 per cent, recognized as valid in table 9 occur solely in the wetter parts of either eastern Australia or southwestern Australia. This is one of the striking facts about the distribution of Aus-

tralian frogs. Twenty-one additional species have ranges that extend into one or both of these humid regions. Thus 89 per cent occur within areas having an average rainfall of more than 25 inches.

An attempt is made here to group the species that have similar patterns of distribution; the question of recognizing zoogeographical areas is then considered. All Australian frogs are discussed. The details of distribution for the eastern New South Wales species are given in the body of this report. For the remaining species, the details are not given, but a general statement regarding their distributions will be found in table 9.

EAST COAST PATTERN

Essentially all of Tasmania, southern Victoria, and the area east of the Dividing Range in New South Wales and Queensland have an annual rainfall of more than 25 and generally more than 30 inches (fig. 72). Tasmania and Victoria are regions of winter rains. In Queensland the rains come during the summer, and in New South Wales the rainfall is fairly well distributed throughout the year.

A total of 41 species, or 43 per cent of the entire Australian fauna, has ranges that are restricted to the humid portions of eastern Australia (see list below). It must be emphasized that all 41 species are not found throughout this region. Only a single species, *Limnodynastes peroni* (fig. 18), extends from northern Queensland to Tasmania. Other species, however, extend over a considerable latitude. Examples are *Hyla gracilentia* (fig. 48), *Adelotus brevis* (fig. 8), *Lechriodus fletcheri* (fig. 6), and *Mixophyes fasciolatus* (fig. 2). Most of the species are restricted to a small portion of the humid east coast. *Crinia tasmaniensis* and *Hyla burrowsi* are known only from Tasmania. Other examples of restricted ranges are *Philoria frosti* and the two species of *Kyarranus* (fig. 26), *Crinia haswelli* (fig. 31), *Pseudophryne australis* (fig. 34), *Pseudophryne dendyi* (fig. 36), *Pseudophryne coriacea* (fig. 37), and *Hyla dentata* (fig. 54).

Mixophyes fasciolatus (fig. 2)

Cyclorana brevipes

Cyclorana inermis

Cyclorana slevini

Lechriodus fletcheri (fig. 6)

Adelotus brevis (fig. 8)

Limnodynastes peroni (fig. 18)

Philoria frosti (fig. 26)

Kyarranus loveridgei (fig. 26)

Kyarranus sphagnicolus (fig. 26)

Crinia acutirostris

Crinia darlingtoni

Crinia laevis

Crinia haswelli (fig. 31)

Crinia tasmaniensis

Pseudophryne australis (fig. 34)

Pseudophryne coriacea (fig. 37)

Pseudophryne corroboree (fig. 38)

Pseudophryne dendyi (fig. 36)

Pseudophryne major

Pseudophryne semimarmorata

Bufo marinus

Hyla aurea aurea (fig. 70)

Hyla booroolongensis (fig. 60)

Hyla burrowsi

Hyla chloris (fig. 46)

Hyla citropa (fig. 52)

Hyla dayi

Hyla dentata (fig. 54)

Hyla freycineti (fig. 66)

Hyla gracilentia (fig. 48)

Hyla infrafronata

Hyla jervisiensis (fig. 56)

Hyla nannotis

Hyla phyllochroa (fig. 42)

Hyla serrata

Rana daemeli

Sphenophryne gracilipes

Sphenophryne polysticta

Sphenophryne robusta

Cophixalus ornatus

SOUTHWEST PATTERN

Only a small portion of the southwest has an annual rainfall of more than 30 inches. Nonetheless there is a rich and largely endemic frog fauna. This is a region of winter rains. (In the northern part of Western Australia there are areas of equivalent rainfall, but, because the rains come in the summer, evaporation is great, hence the precipitation is less effective for the frogs. As a consequence, the southwest has many more species than the northwest.)

The 21 species that are restricted to the humid portion of the southwest are listed below. It must be emphasized that the patterns of distribution for the individual species are unique; I know of no two that are identical. Many species occur only in very restricted zones. *Hyla adelaidensis* may be a

special case. It has generally been thought of as restricted to the southwest, but recently it has been reported from the Northern Territory. If the report is true, *Hyla adelaidensis* is the only species that shows this peculiar distribution.

Neobatrachus pelobatoides (fig. 12)
Neobatrachus sutor
Neobatrachus wilsmorei (fig. 12)
Heleioporus albopunctatus (fig. 10)
Heleioporus eyrei (fig. 10)
Heleioporus inornatus
Heleioporus psammophilus
Crinia georgiana
Crinia glauerti
Crinia insignifera (fig. 32)
Crinia leai
Crinia pseudinsignifera (fig. 32)
Crinia rosea
Crinia subinsignifera (fig. 32)
Myobatrachus gouldi
Metacrinia nichollsi
Pseudophryne guentheri
Pseudophryne occidentalis
?Hyla adelaidensis
Hyla cyclorhynchus (fig. 70)
Hyla moorei (fig. 70)

EAST COAST AND SOUTHWEST PATTERN

A single species, *Heleioporus australiacus* (fig. 10), has a disjunct distribution. One population occurs in the humid southwest; another, in a small area near Sydney, New South Wales. Thus, with 41 species restricted to the humid east coast, 21 to the humid southwest, and one occurring in both regions but not elsewhere, a total of 63 of the 94 species are accounted for.

NORTHEAST CRESCENT PATTERN

The isohyets above 32 inches extend roughly north and south in eastern Australia. Those below 30 inches extend north and south in the area south of the twenty-eighth parallel, but to the north of this latitude they turn westward and reach the coast in northwest Western Australia (fig. 72). Thus the area with more than 20 inches of rain forms a crescent that centers on the northeast corner of the continent.

Ten species have a pattern of distribution that is the basis for recognizing the Northeast Crescent Pattern. These forms occur along the humid east coast, but they seem to tolerate more arid conditions than those species

showing the East Coast Pattern, for they extend farther inland and also follow the isohyets westward across northern Australia.

The species showing the Northeast Crescent Pattern can be arranged on the basis of increasing tolerance to arid conditions.

Hyla nasuta (fig. 68) and *Hyla bicolor* (fig. 40) hug the coast. All records of their occurrence are from localities having an annual rainfall of more than 30 inches. If their distribution is limited by the 30-inch isohyet, or one close to it, it would be interesting to know if their ranges are continuous around the Gulf of Carpentaria. The 30-inch isohyet reaches the coast at the southern end of the Gulf. Thus the areas of the Northern Territory and northeastern Queensland that have an annual rainfall of more than 30 inches (where *Hyla bicolor* and *Hyla nasuta* occur) are isolated from one another by a broad band of arid country. *Limnodynastes convexiusculus* has a similar distribution.

Hyla latopalmata (fig. 64), *Cyclorana alboguttatus* (fig. 4), and *Cyclorana australis* extend farther inland and occur in areas averaging as little as 20 inches of rainfall a year.

An extreme is reached in the cases of *Hyla caerulea* (fig. 44), *Hyla rubella*, and *Crinia signifera* (fig. 32) which occur not only along the humid east coast but reach the driest regions of the center of the continent. *Cyclorana dahli* is included here for convenience, but very little is known of its distribution.

The ten species having the Northeast Crescent pattern are:

Cyclorana alboguttatus (fig. 4)
Cyclorana australis
Cyclorana dahli
Limnodynastes convexiusculus
Crinia signifera (fig. 32)
Hyla bicolor (fig. 40)
Hyla caerulea (fig. 44)
Hyla latopalmata (fig. 64)
Hyla nasuta (fig. 68)
Hyla rubella

The 21 remaining species of the total for the continent can be grouped with even less certainty on the basis of common patterns of distribution. My attempt should not be taken too seriously, but, in an effort to consider all the species, those remaining are divided into three groups.

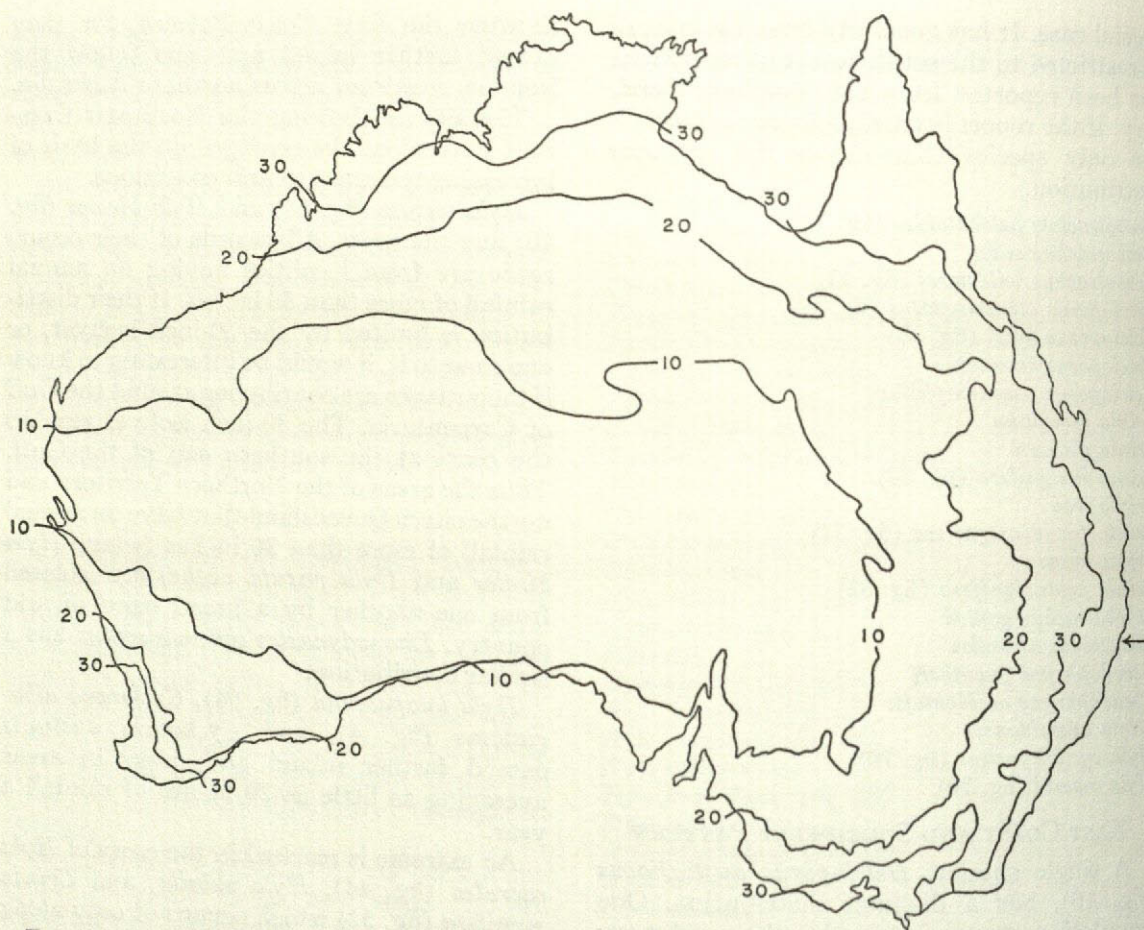


FIG. 72. A simplified rainfall map of Australia. Based on "Map of Australia showing average annual rainfall revised to 1938" of the Meteorological Branch, Department of Interior, Commonwealth of Australia. The arrow on the east coast points to the mouth of the Clarence River, which is the dividing line of the Torresian (northern) and Bassian (southern) faunal regions.

SOUTHEAST CRESCENT PATTERN

There is another group of 10 species (see list below) that have their centers of distribution in the southeastern part of the continent. These should be thought of as an analogue of the species showing the northeast crescent pattern. These species may occur in the east coast humid zone, but they extend inland farther than the species showing the east coast pattern. *Crinia parinsignifera* and *Crinia sloanei* (fig. 32) occur within the southeastern area, but their ranges are either very small or incompletely known.

- Neobatrachus pictus* (fig. 12)
- Limnodynastes fletcheri* (fig. 22)
- Limnodynastes salmini* (fig. 24)
- Limnodynastes tasmaniensis* (fig. 20)
- Crinia parinsignifera* (fig. 32)

- Crinia sloanei* (fig. 32)
- Pseudophryne bibroni* (fig. 35)
- Hyla aurea raniformis* (fig. 70)
- Hyla ewingi* (fig. 58)
- Hyla lesueuri* (fig. 62)

CENTRALIAN PATTERN

Seven species occur only in the arid areas of Australia (see list below). The distribution of them is poorly known, but many seem to be rather restricted. Records of their occurrence are nearly always in areas averaging less than 20 inches of rainfall. If they come near the coast, it is only in the west and northwest where the arid zone also reaches the coast.

- Cyclorana cultripes*
- Cyclorana platycephalus*
- Neobatrachus centralis* (fig. 12)
- Notaden bennetti*

Notaden nichollsi
Glauertia mjobergi
Glauertia russelli

WIDESPREAD SPECIES

This is a dubious category, and I believe that its recognition is the result of some errors in locality records. *Limnodynastes ornatus* (fig. 16), *Uperoleia marmorata* (fig. 29), and *Hyla peroni* (fig. 50) are widespread in eastern and northern Australia to the Kimberleys. There is an old record for each of them from the Albany area in the southwest. Not one of them has since been collected there, or in any part of the southwest. If we disregard these records, the three species would show the Northeast Crescent Pattern of distribution.

Limnodynastes dorsalis (fig. 14), as currently recognized, has a distribution that might be classed as a Peripheral Pattern, which is the supplement of the Centralian Pattern. Data on interpopulation hybridizations and field biology are necessary before we can accept as final the statement that *Limnodynastes dorsalis* occurs over the entire continent. The form in the southwest may be specifically different from the forms occurring elsewhere.

Limnodynastes dorsalis (fig. 14)
Limnodynastes ornatus (fig. 16)
Uperoleia marmorata (fig. 29)
Hyla peroni (fig. 50)

Having put all the Australian frogs into one pattern or another, I wish to make some general remarks and consider specific details.

There seems to be no need to recognize a distinct pattern of distribution centering on the northwest. This may seem surprising in view of the fact that it is possible to recognize a Southwest Pattern, Northeast Crescent Pattern, and Southeast Crescent Pattern. Only three species are restricted to the northwest. These are *Notaden nichollsi*, *Glauertia mjobergi*, and *Glauertia russelli*. *Notaden nichollsi* is known from several localities in the Kimberley Division, and *Glauertia mjobergi* from one locality. *Glauertia russelli* is known from the type locality on the Gascoyne River and from Weeli Wolli on the Fortescue River. Both localities are about 200 miles from the coast. I have thought of these species as having more in common with the centralian species and have so classified them.

It must be apparent that the classification of the patterns is rather arbitrary. Another classification, which would be almost as reasonable, could be made by a division of the continent into four segments on lines drawn north, south, east, and west from Alice Springs to the coasts.

If one wishes to be very strict, one must admit that the patterns can be divided into only two general categories. One category includes the species of the southwest, and the other includes those of the remainder of Australia. In both categories, however, the distribution of each species is unique.

Attempts to group the patterns are arbitrary, as the patterns form a spectrum rather than neat bundles, which can be demonstrated if one arranges the species according to the extent that they are able to penetrate inland from the east coast. No doubt this spectrum is a sequence of increasing ability to withstand extremes of moisture. *Hyla gracilentia* (fig. 48), *Crinia haswelli* (fig. 31), and *Lechriodus fletcheri* (fig. 6) are at one extreme. They are found only near the coast. Next come *Mixophyes fasciolatus* (fig. 2), *Adelotus brevis* (fig. 8), and *Hyla phyllochroa* (fig. 42), which extend inland to the Dividing Range but seem not to go beyond it. *Limnodynastes peroni* (fig. 18), *Pseudophryne bibroni* (fig. 35), and *Hyla lesueuri* (fig. 62) cross the Dividing Range, especially in the southern part of their ranges. Next, *Limnodynastes tasmaniensis* (fig. 20), *Limnodynastes salmini* (fig. 24), and *Limnodynastes fletcheri* (fig. 22) extend farther inland. The next steps are taken by those species that extend inland and across northern Australia into ever drier areas, such as *Hyla latopalmata* (fig. 64) and *Cyclorana alboguttatus* (fig. 4). Finally, species such as *Hyla caerulea* (fig. 44) and *Limnodynastes ornatus* (fig. 16) are present in the very humid areas of northeast Queensland and in the arid country around Alice Springs in the center.

More species show the East Coast Pattern than any other. This is also the most heterogeneous category, doubtless because it is the largest. A classification, almost as useful as the one here proposed, could be made by separating those species found only in the southeast and recognizing them as a separate category or combining them with the species

of the southeast crescent pattern. Similarly, those of the northeast could be regarded as a distinct northeast element or, with less justification, lumped with the northeast crescent species.

The frogs of northeast Queensland are, however, a distinct assemblage with relation to the New Guinea fauna. The frogs restricted to this area are *Crinia acutirostris*, *Hyla dayi*, *Hyla infrafrenata*, *Hyla nannotis*, *Hyla serrata*, *Rana daemeli*, *Sphenophryne gracilipes*, *Sphenophryne polysticta*, *Sphenophryne robusta*, and *Cophixalus ornatus*.

It is difficult enough to recognize common patterns of distribution and nearly impossible to delimit zoogeographical regions within Australia. But there has been intense interest in this subject since the close of the nineteenth century so it must be considered.

ZOOGEOGRAPHICAL SUBREGIONS

As Keast (1959) has shown recently, there is much similarity among the various proposals for dividing Australia into different regions on the basis of plant and animal distributions. He has provided maps that show the different schemes.

Tate (1889) listed three regions, and implied a fourth, that were based on plant associations. The "Euronotian" plants were dominant in Tasmania and the southern and eastern parts of Australia. The "Autochthonian" plants were found in the region having more than 20 inches of rainfall in the southwestern corner of the continent. The "Eremian" region was that having less than 10 inches of rainfall and was primarily central. Another region was implied, for he spoke of the Eremian region as being bordered on the north and northeast by a zone having "Indo-Australian" vegetation.

Hedley (1894) modified Tate's classification by dividing the Euronotian region into two parts. The name "Euronotian" was restricted to the fauna and flora of Tasmania, Victoria, and southern New South Wales. The "very distinct fauna and flora developed on the coasts of Queensland and northern New South Wales would be best described as Papuan." He remarks, "that a separation of Australian life into Papuan and non-Papuan seems to the writer to be the primary divi-

sions into which fall the Australian fauna and flora."

Spencer (1896a) recognized approximately the same regions but gave them new names. The "Bassian" subregion consisted of the coastal area in the southeast that was south of the mouth of the Clarence River of northern New South Wales. The "Torresian" subregion comprised the coastal areas of Queensland, the Northern Territory, and northwest Western Australia. The remaining parts of Australia, including the southwest, were lumped as the "Eyrean" subregion.

Serventy and Whittell (1951), in their treatment of the birds of Western Australia, used Spencer's subregions except that they found it necessary to recognize a southwest subregion (corresponding approximately to Tate's Autochthonian region) where both Bassian and Eyrean species intermingle. Thus there are four zoogeographical subregions in Australia. Similar divisions are used for the Diptera (Paramanov, 1959) and, with slight modifications, for grasshoppers and locusts (Key, 1959) and land mollusks (McMichael and Iredale, 1959). On the other hand, Keast (1959) found that "considerable generalization is necessary to get the bulk of reptiles to fit" into the faunal province categories.

Two very important points should be made about these efforts to delimit zoogeographical areas in Australia. First, no one has given a clear statement of his basis for recognizing a zoogeographical subregion. It is assumed, I suppose, that it is obvious. It is not. Second, no one has given adequate data for evaluating the reality of the zoogeographical subregions that are proposed. The recognition of zoogeographical subregions should emerge from detailed maps of the distributions of many species. The required data have not been provided.

Because no definition of a zoogeographical subregion is generally agreed upon, it is necessary to say a few words about this concept. My purpose is to show how I am using the concept and certainly not to suggest how others should use it. It should also be emphasized that I am not considering the major zoogeographical divisions of the land masses of the earth. On this basis Australia and some of the nearby islands form a single region. It

is with the subdivisions of Australia that I am concerned.

The criteria I use for recognizing zoogeographical regions include both the existing situations and their origins, as follows.

1. A zoogeographical region must have boundaries, and it should be possible to determine these boundaries with a moderate degree of precision. In some instances the boundaries may be located fairly exactly, such as at the junction of land and sea or at a mountain range that divides a humid zone from a desert. In other instances the boundaries are less precise and may be a narrow zone rather than a sharp line. But this zone cannot be too broad, or the zoogeographical region will have little utility.

2. A zoogeographical region should have a fauna markedly different from that of the adjacent zoogeographical regions. If however, there are only slight differences, there is no need to recognize a separate region. Probably any large land mass could be divided into halves, quarters, eighths, or sixteenths and each subdivision be characterized by some organism or unique grouping of organisms, but such a division would not be very useful. Each region must have numerous endemic species.

3. A significant proportion of the fauna characteristic of a zoogeographical region should have ranges approximately coextensive with the region. This criterion is most important; by ignoring it, animal geographers have frequently delimited zoogeographical regions that are little more than the ranges of one or several species.

This point can be developed with the aid of figure 73. The ranges of nine species are shown very roughly by ovals. (For the purposes of the argument these ranges could have been wholly imaginary, but actually they are based on nine different species of frogs.) It would be possible to recognize two (or more) zoogeographical regions on the basis of these distributions, and these regions could be adequately characterized by the presence of endemic species. Thus an east-west line could be drawn at several places to isolate faunas. If the position was between the ranges of C and D, there would result a "northern zoogeographical region" characterized by species A

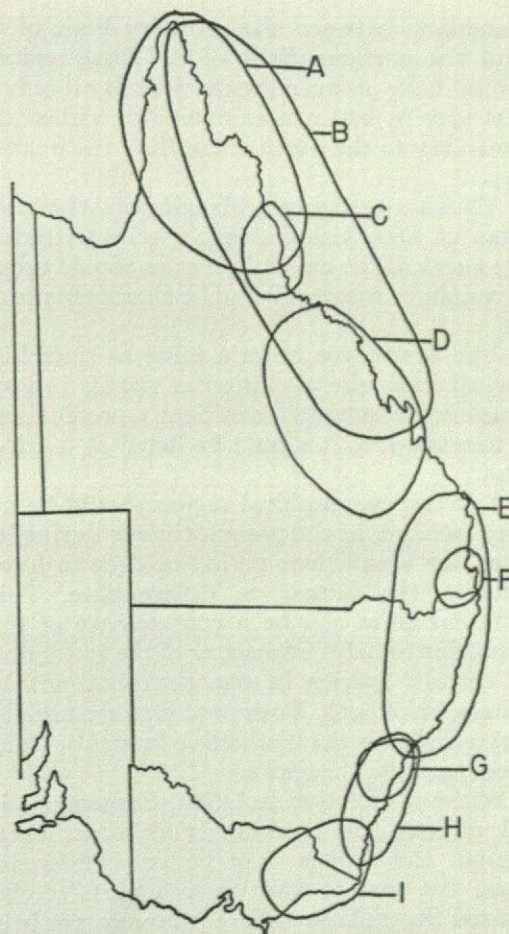


FIG. 73. The distributions of nine species, A through I. The ranges are very schematic but are based on actual species.

and C, and a "southern zoogeographical region," with D, E, F, G, H, and I as the characteristic species. Species B would be "wide ranging." The selection of this boundary is arbitrary: it could as well be south of D, or of E, or of F.

The regions so defined meet criteria 1 and 2 but not criterion 3, and for this reason I believe it is pointless to recognize them.

If, on the other hand, there were many species with ranges extending roughly from the northern limit of A to the southern limit of D, and other species with ranges from the northern limit of E to the southern limit of I, there would be a valid reason for recognizing two zoogeographical regions, with their

boundary between the southern limit of D and the northern limit of E. These regions would have an even greater validity if only a few species had ranges extending either appreciably to the north or south of the boundary.

Thus a zoogeographical region must be more than an area with endemic species (criterion 2): *many* of the endemic species should occur throughout the region and be characteristic of it.

The first three criteria have as their historical basis the evolution of faunas in geographically isolated areas. Such a prerequisite is necessary, so it should be listed as a criterion.

4. A zoogeographical region should be an area isolated, at the present time or during its past, for a sufficient period of time to have allowed the faunas to differentiate. This differentiation can be a consequence of the evolution of unique forms, or of the extinction of certain species in one area but not in others, or of both. Both processes are usually responsible for the distinctive faunas of valid zoogeographical regions.

Without effective isolation, zoogeographical regions are exceedingly dubious, even though the faunas may be very different. Thus the eastern and western parts of the United States have different faunas, yet it is not usual to consider them as separate zoogeographical regions. There is no reasonable way to draw a boundary, owing to the fact that the two areas have not been effectively isolated in recent times. North America and South America, on the other hand, can be considered separate zoogeographical regions. They were long separated, and in each there was evolution as well as differential extinction that resulted in two unique faunas. After they were joined there was intermingling of the faunas but not to the extent that makes a recognition of their distinctness unjustified. It is impossible, however, to draw a sharp boundary between these two regions and it is not useful to attempt to do so. They are separated by a zone. Because the area of this zone is a small fraction of the area of the zoogeographical regions that it separates, these regions are valid.

Australia and adjacent islands form a distinct, major, zoogeographical region. Long

isolation, during which some species have evolved and others have become extinct, has resulted in the distinctive fauna. Such distinctiveness is true for many groups of animals and plants, of course, and not for the frogs alone.

These four criteria, in my opinion, must be met if zoogeographical regions are to be recognized. There is, however, a qualification. In the case of major zoogeographical regions (Nearctic, Ethiopian, Australian), the first, second, and fourth must be met but not necessarily the third. For zoogeographical subregions, such as the divisions of Australia, all four criteria must be met.

Zoogeographical regions should have other attributes, if possible, such as applicability to many groups and a botanical and climatic basis. With these attributes their validity is greater, but these criteria are not so important as the first four.

If we apply these criteria and attempt to delimit zoogeographical regions in Australia, the result is that we can recognize a distinct zoogeographical region in the southwest, but the rest of the continent cannot be divided in any satisfactory manner.

This statement may come as a surprise when we remember that Spencer's (1896a) zoological regions, or modifications of them (Keast, 1959), have been widely supported (but the support comes, I believe, more from the zoogeographers than from the fauna). Apart from southwest Australia, which Spencer did not recognize as a separate region although many of his followers did, Australia was divided into a central Eyrean region, a southeast Bassian region, and a northeast and northern Torresian region. The boundary between the Eyrean and the Torresian plus Bassian regions coincides roughly with the 20-inch isohyet (fig. 72). The division between the Torresian and Bassian regions is the Clarence River in northeast New South Wales. The validity of these proposed regions can be tested by ascertaining whether or not their boundaries compare with the realities of the distributions of frogs.

A test of the Clarence River as the boundary between the Bassian and Torresian regions is given in figure 74. The northern and southern limits of all the eastern New South Wales species described in this report are

plotted on an outline map. As these are Bassian species, their northern limits should cluster near the Clarence River. They do not. (The southern limits of these species have also been plotted but merely for interest; naturally they are not a test of the boundary between the Torresian and Bassian regions.)

Figure 74 does not show the southern limits of species occurring only in Queensland. Had these been plotted, the conclusion would be the same: the Clarence River is not a natural boundary between zoogeographical regions that can be recognized on the basis of the distribution of frogs.

The limits of western distribution, also, do not coincide with Spencer's boundaries of the Eyrean region, as can be seen by an examination of the distribution maps that are given with the accounts of the species. There is no clustering of the western boundaries near the 20-inch isohyet, but there is near the Dividing Range in New South Wales. This clustering is less apparent in Queensland. The explanation of why I do not use this fact to recognize a zoogeographic region follows.

In the first part of the section on Patterns of Distribution, it was mentioned that the east coast pattern was the most frequent. To recapitulate, the facts are these: 41 species have ranges restricted to the humid area along the east coast of Australia, and in New South Wales and Queensland the western boundary for these species coincides rather well with the Dividing Range. Thus, this area fulfills three of the requirements of a zoogeographical region. It has well-defined boundaries, many endemic species, and is somewhat isolated (in this instance by the more arid country of the interior). It fails, however, to meet the criterion of having many species occupying a large portion of the region. The distribution of the species in the east coast humid area is essentially like that shown in figure 73. Only one species of the 41 occupies all, or nearly all, of the region; the rest have very restricted north-south distributions. There is, consequently, little resemblance between the frogs of the northeast coastal areas of Queensland and the southeast corner of the continent. Therefore, I have not recognized this area as a zoogeographical region.

There is even less reason to delimit zoogeographical regions on the basis of the Northeast

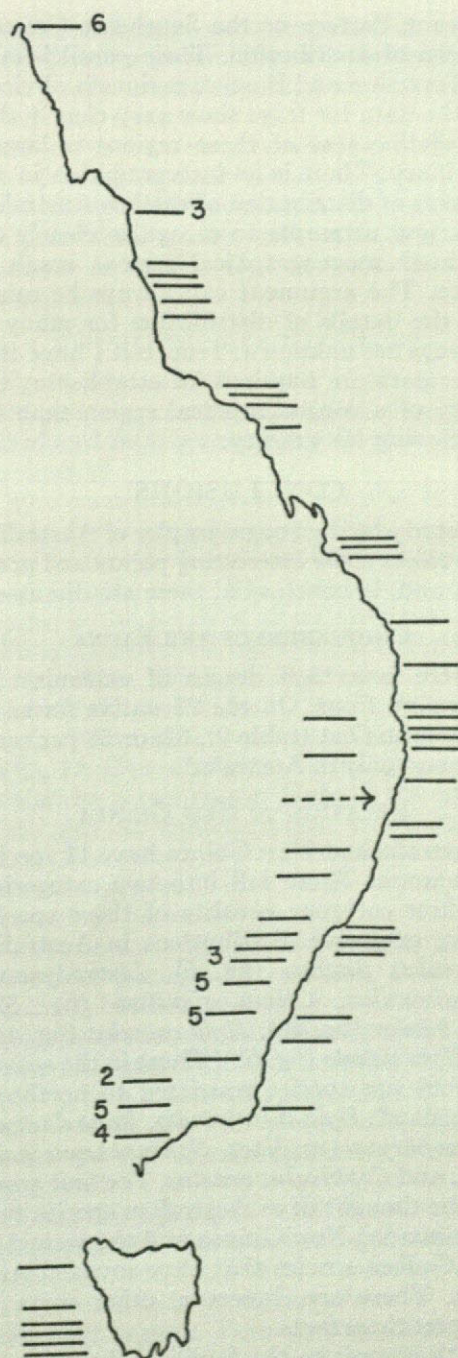


FIG. 74. The northern and southern limits of the ranges of the frogs of eastern New South Wales. The lines to the right of the coast show the northern limits; those to the left, the southern limits. The numbers indicate the ranges ending at the point shown. The arrow indicates the position of the mouth of the Clarence River.

Crescent Pattern or the Southeast Crescent Pattern of distribution. Their parallelism to the Torresian and Bassian regions is obvious, but the data for frogs show very clearly that any distinctness of these regions is largely imaginary. There is an intergradation in the patterns of distribution of eastern Australian frogs, and attempts to recognize clearly demarcated zoogeographical regions result in failure. The argument can always be raised that the details of distribution for many of the frogs are unknown. True, but I hope that better data are required for establishing the reality of a zoogeographical region than for questioning its validity.

CONCLUSIONS

A study of the zoogeography of Australian frogs raises some interesting points and problems, and, in conclusion, these are discussed.

UNIQUENESS OF THE FAUNA

There is a high degree of endemism in Australian frogs. On the 93 native forms in the synoptic list (table 9), 82, or 88 per cent, are found only in Australia.

RELATION TO NEW GUINEA

Australia and New Guinea have 11 species in common. These fall into two categories. The first category consists of those species having extensive distributions in Australia: *Lechriodus fletcheri* (fig. 6), *Limnodynastes convexiusculus*, *Crinia signifera* (fig. 32), *Hyla bicolor* (fig. 40), *Hyla caerulea* (fig. 44), and *Hyla nasuta* (fig. 68). Those in the second category are species restricted to northeast Queensland: *Hyla infrafrenata*, *Rana daemeli*, *Sphenophryne gracilipes*, *Sphenophryne polysticta*, and *Cophixalus ornatus*. The first group may be thought of as Australian species that have invaded New Guinea and the second as New Guinea species that have invaded Australia. There are, however, other ways to interpret these facts.

With respect to the families, the evidence suggests that the Ranidae and Microhylidae are recent invaders of Australia. The Ranidae are represented by a single species of *Rana* in Australia, whereas Loveridge (1948) lists 11 species, belonging to three genera, in New Guinea. Furthermore, the family is well represented throughout the East Indian Archi-

pelago and southeast Asia. While there are only four species (one endemic) and two genera of the Microhylidae in Australia, Zweifel (1956) lists 56 species, belonging to eight genera, in New Guinea.

The Hylidae are common in both Australia and New Guinea. Australia has 25 species of *Hyla*. According to Loveridge (1948), New Guinea has 33 species of *Hyla* and six species of *Nyctimystes*. Zweifel (1958) has increased the number of *Nyctimystes* to 13. The Hylidae become increasingly infrequent to the west. They are wholly absent in the western part of the East Indian Archipelago (Mertens, 1930b). These facts suggest that the Hylidae have been in both Australia and the western islands of the East Indian Archipelago for a long time. (The Hylidae are poorly represented in Asia, Europe, and Africa; they are numerous in North and South America.)

New Guinea has six species and three genera of the Leptodactylidae (Loveridge, 1948). Three of these species and all the genera occur in Australia as well. Australia has 62 species and 16 genera. These facts could be interpreted to show that the family is primarily Australian and is now invading New Guinea. (The Leptodactylidae occur elsewhere only in the New World, where there are numerous species and genera.)

DISTINCTNESS OF SOUTHWEST FAUNA

The frogs of the humid southwestern portion of the continent form a distinct group. Twenty, or possibly 21, species in the total of the 24 that occur there are endemic (87% or 91%). However, only two genera, each with a single species, are endemic. A possible explanation of this endemism, which is mostly on a species level, is to be sought in the long isolation of this area by the arid lands that surround it, together with occasional contacts with eastern Australia during more recent humid periods.

THE PAUCITY OF SPECIES IN TASMANIA

Climatically speaking, Tasmania appears to be ideal for frogs. It has only 11 species, a number lower than that for any other state. Two species are endemic (one is closely related to a mainland species; the other is not well known). A smaller and less varied area in the vicinity of Sydney has 27 species. Do

these facts indicate that frogs were exterminated, or nearly so, in Tasmania not very long ago and that in more recent times there have been re-invasions? Victoria also has a surprisingly small number of species.

DISJUNCT DISTRIBUTIONS

An interesting example of what is presumably the same species (but this supposition should be tested) occurs in widely separated areas. *Heleioporus australiacus* (fig. 10) is found in a small area in east central New South Wales and in southwest Western Australia but not elsewhere. This case should probably be interpreted as an example of a relict distribution: the species once had a continuous distribution but is restricted to the two separate areas at the present time.

THE CENTRALIAN SPECIES

The species found in the arid regions of the center of Australia are clearly related to the species that are found in the peripheral areas of the continent, a fact that was recognized by Spencer (1896b). In some instances the centralian species have been given different subspecific or even specific names, but the differences are extremely slight. Only a single species is unequivocally restricted to the arid zone—*Cyclorana platycephalus*. The relationships and distributions of the other species occurring in the center are as follows: *Limnodynastes ornatus* (fig. 16) occurs from one side of Australia to the other. The centralian populations have been described as a different species, *Limnodynastes spenceri*, which I do not regard as valid. *Cyclorana cultripes*, which is recorded only from the arid zone, is said by its describer (H. W. Parker, 1940) to be so closely allied to *Cyclorana brevipes* that the two may be only racially distinct. *Cyclorana brevipes* reaches the coast in Queensland. A single species of *Neobatrachus* occurs in the center, and for years it was called *Neobatrachus pictus* (fig. 12). It was described by H. W. Parker in 1940 as new, *Neobatrachus centralis*. The differences between the two are slight, and I doubt the validity of the centralian species. *Hyla rubella* occurs from coastal Queensland to the center. *Hyla caerulea* (fig. 44) has a similar distribution. Spencer (1896b) thought it a distinct species, *Hyla gilleni*, but Copland (1957) demoted it to a

subspecies. I have not recognized it as distinct. *Crinia signifera* (fig. 32) also seems to occur in the center and it, too, is a widely distributed species.

I think that we must conclude that the dry central areas of Australia have a poor frog fauna and that the species that do occur there are generally identical with or have obvious relations to species that are widespread in Australia.

DISTRIBUTIONS OF THE GENERA

Rana, *Sphenophryne*, and *Cophixalus* are restricted to northeastern Queensland. The introduced *Bufo* occurs along the east coast of Queensland.

Hyla occurs throughout Australia. It is not evenly distributed, being relatively more frequent in the north and east and less frequent in the southwest. The percentages of its species in the totals of all amphibians are as follows: Queensland, 34; Northern Territory, 45; northern Western Australia, 38; New South Wales, 40; Victoria, 26; Tasmania, 27; South Australia, 31; southern Western Australia, 13. (For all regions except Queensland this is the percentage of *Hyla* in the total of *Hyla* plus all leptodactylids. If we exclude *Bufo*, *Rana*, and the microhylids from the Queensland total, the value for *Hyla* in Queensland becomes 39.)

The genera of the Leptodactylidae show a variety of patterns. *Mixophyes*, *Lechriodus*, *Adelotus*, *Philoria*, and *Kyarranus* occur only along the east coast. *Myobatrachus* and *Metacrinia* are restricted to the southwest. These seven genera are monotypic, except for *Kyarranus* which has two species. (In addition, *Lechriodus* has several species in New Guinea.)

There are eight species of *Cyclorana*. These occur across northern Australia, sometimes in exceedingly dry habitats. *Neobatrachus* has five species, which occur primarily in the more arid regions. Four species occur in the southwest, three being endemic. As is *Neobatrachus*, *Heleioporus* is centered in the southwest. All the species are found there, and one also occurs in the east. *Limnodynastes* is one of the largest leptodactylid genera. Its center of distribution is eastern Australia, but it is found in all areas.

Notaden is a poorly known genus of two

species. One occurs in the east and the other in the northwest, both occurring in arid environments. *Glauertia*, also poorly known and restricted to the arid zone, has two, or possibly three, species in the Northern Territory and Western Australia. *Uperoleia* has one, or possibly two, species that occur in all states except Victoria, Tasmania, and South Australia.

Crinia is a large genus of 15 species. There are two centers of abundance, one in the

southeast and another in the southwest. *Pseudophryne* has nine species, with a center of abundance in the southeast.

The leptodactylid species are relatively more frequent in the south and southwest. Their percentages in the totals of all species are: Queensland, 53; Northern Territory, 55; northern Western Australia, 62; New South Wales, 60; Victoria, 74; Tasmania, 73; South Australia, 69; southern Western Australia, 87.

HYBRIDIZATION EXPERIMENTS

FIFTY CROSSES were made between individuals of different species and different geographic representatives of the same species. The results are summarized in table 11. In every experiment a control was made by fertilizing the ova with sperm of the same species. It was not possible, however, to perform control experiments to test the normality of the sperm, that is, to use them to fertilize ova of their own species. In some experiments the ova of a single female were fertilized with the sperm of many different males, and occasionally the sperm of a single male were used to fertilize the ova of two females. For example, in crosses 3-8 the ova of a single female were used. The same is true for crosses 9-14. In crosses 4 and 10, as well as in 5 and 11, sperm of the same male were used.

Hybridization is a useful tool for obtaining information on the interrelations of populations of frogs. For the most part the results substantiate the conclusions based on morphological study of the different species, that is, individuals thought to be different species do not produce viable hybrids. The single exception is cross 2 (*Limnodynastes tasmaniensis* ♀ × *Limnodynastes peroni* ♂) which gives hybrids that develop normally to the juvenile stage. (They probably would have

developed to adults had it been possible to keep them long enough.)

In two instances (crosses 37-40 and 47-50) the data show that two populations previously thought to be conspecific are actually different species.

Some intraspecific crosses, such as 29, 30, 32, 34, 35, and 36, result in normal offspring even though the parents are from widely separated, and ecologically different, areas. Another intraspecific cross (15), of Killara and Binna Burra individuals of *Limnodynastes peroni*, seems to show incipient genetic isolation. This species would be interesting to study, as it has an extensive distribution. A cross of individuals from the northern and southern portions of its range might result in inviable offspring, and, if so, it would resemble *Rana pipiens* (Moore, 1946).

I found it surprising that such a large number of the crosses produced haploid larvae. The embryos were tentatively classified as haploids on the basis of their external characteristics, and confirmation was made by chromosome counts, which were done by Betty C. Moore.

Some of the evolutionary and embryological implications of these crosses have been discussed previously (Moore, 1954a, 1955).

TABLE 11
HYBRIDIZATION EXPERIMENTS

Female	Male	Extent of Development
1 <i>Adelotus brevis</i> Binna Burra, Queensland	<i>Kyarranus loveridgei</i> Binna Burra, Queensland	Arrested in stage 10
2 <i>Limnodynastes tasmaniensis</i> Burradoo, New South Wales	<i>Limnodynastes peroni</i> Pittwater, New South Wales	Reached the juvenile stage (not kept longer); intermediate in pigmentation
3 <i>Limnodynastes peroni</i> Killara, New South Wales	<i>Limnodynastes dorsalis</i> Burradoo, New South Wales	Arrested in stage 17
4 <i>Limnodynastes peroni</i> cross 3 ♀	<i>Adelotus brevis</i> Ebor, New South Wales	Arrested in stage 12
5 <i>Limnodynastes peroni</i> cross 3 ♀	<i>Kyarranus sphagnicolus</i> Point Lookout, New South Wales	Arrested in stage 10
6 <i>Limnodynastes peroni</i> cross 3 ♀	<i>Neobatrachus pictus</i> Mt. Stromlo, Australian Capital Territory	Arrested in stage 10

TABLE 11—(Continued)

Female	Male	Extent of Development
7 <i>Limnodynastes peroni</i> cross 3 ♀ Killara, New South Wales	<i>Crinia signifera</i> Killara, New South Wales	No cleavage (58 eggs)
8 <i>Limnodynastes peroni</i> cross 3 ♀ Killara, New South Wales	<i>Pseudophryne australis</i> Killara, New South Wales	No cleavage (131 eggs)
9 <i>Limnodynastes peroni</i> Killara, New South Wales	<i>Limnodynastes dorsalis</i> cross 3 ♂	Arrested in stage 17
10 <i>Limnodynastes peroni</i> cross 9 ♀	<i>Adelotus brevis</i> cross 4 ♂	Arrested in stage 12
11 <i>Limnodynastes peroni</i> cross 9 ♀	<i>Kyarranus sphagnicolus</i> cross 5 ♂	Arrested in stage 10
12 <i>Limnodynastes peroni</i> cross 9 ♀	<i>Neobatrachus pictus</i> cross 6 ♂	Arrested in stage 10
13 <i>Limnodynastes peroni</i> cross 9 ♀	<i>Crinia signifera</i> cross 7 ♂	No cleavage (195 eggs)
14 <i>Limnodynastes peroni</i> cross 9 ♀	<i>Pseudophryne australis</i> cross 8 ♂	No cleavage (188 eggs)
15 <i>Limnodynastes peroni</i> Killara, New South Wales	<i>Limnodynastes peroni</i> Binna Burra, Queensland	Some retardation in rate; minor morphological abnormalities
16 <i>Limnodynastes peroni</i> cross 15 ♀ Killara, New South Wales	<i>Lechriodus fletcheri</i> Binna Burra, Queensland	Arrested in stage 14
17 <i>Crinia signifera</i> Killara, New South Wales	<i>Hyla ewingi</i> Killara, New South Wales	Haploid larvae
18 <i>Crinia signifera</i> Killara, New South Wales	<i>Limnodynastes peroni</i> Killara, New South Wales	Haploid larvae
19 <i>Crinia signifera</i> Killara, New South Wales	<i>Pseudophryne australis</i> National Park, New South Wales	Haploid larvae
20 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia haswelli</i> Woy Woy, New South Wales	Died as 9-mm. diploid larvae
21 <i>Crinia signifera</i> Killara, New South Wales	<i>Hyla phyllochroa</i> Killara, New South Wales	Arrested as abnormal neurulae
22 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia rosea</i> Pemberton, Western Australia	No cleavage
23 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia rosea</i> cross 22 ♂	No cleavage
24 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia rosea</i> Pemberton, Western Australia	No cleavage (38 eggs)
25 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia rosea</i> cross 24 ♂	No cleavage (39 eggs)
26 <i>Crinia signifera</i> Killara, New South Wales	<i>Adelotus brevis</i> Ebor, New South Wales	Arrested in stage 9 (single embryo)
27 <i>Crinia signifera</i> cross 26 ♀ Killara, New South Wales	<i>Kyarranus loveridgei</i> Binna Burra, Queensland	Arrested as abnormal neurulae
28 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia tasmaniensis</i> Derwent Bridge, Tasmania	Haploid larvae
29 <i>Crinia signifera</i> cross 28 ♀ Killara, New South Wales	<i>Crinia signifera</i> Lake St. Clair, Tasmania	Normal development (discarded as tadpoles)
30 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia signifera</i> Derwent Bridge, Tasmania	Normal development (discarded as tadpoles)
31 <i>Crinia signifera</i> cross 30 ♀ Killara, New South Wales	<i>Crinia tasmaniensis</i> Derwent Bridge, Tasmania	Haploid larvae
32 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia signifera</i> Derwent Bridge, Tasmania	Normal development (discarded as tadpoles)
33 <i>Crinia signifera</i> cross 32 ♀ Killara, New South Wales	<i>Crinia tasmaniensis</i> Derwent Bridge, Tasmania	Haploid larvae
34 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia signifera</i> Mt. Kosciusko, New South Wales (7000 feet)	Normal development (discarded as tadpoles)

TABLE 11—(Continued)

Female	Male	Extent of Development
35 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia signifera</i> Lake Albina, Mt. Kosciusko, New South Wales	Normal development (discarded as tadpoles)
36 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia signifera</i> Betts Camp, Mt. Kosciusko, New South Wales	Normal development (discarded as tadpoles)
37 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia insignifera</i> Attadale, Western Australia	Rate retarded; formed abnormal larvae; 79% very abnormal; 21% slightly abnormal
38 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia insignifera</i> Attadale, Western Australia	Rate retarded; no normal larvae
39 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia insignifera</i> Attadale, Western Australia	Rate retarded; larvae nearly nor- mal; some raised past trans- formation
40 <i>Crinia signifera</i> Killara, New South Wales	<i>Crinia insignifera</i> cross 39 ♂	Rate retarded; less normal than above; some raised past trans- formation
41 <i>Hyla aurea</i> Burradoo, New South Wales	<i>Hyla bicolor</i> Woy Woy, New South Wales	Arrested as abnormal neurulae
42 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla bicolor</i> Woy Woy, New South Wales	Arrested as abnormal neurulae
43 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla phyllochroa</i> Killara, New South Wales	Haploid larvae
44 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla phyllochroa</i> Killara, New South Wales	Haploid larvae
45 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla adelaidensis</i> Pemberton, Western Australia	Arrested as abnormal larvae
46 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla adelaidensis</i> Pemberton, Western Australia	Arrested as abnormal larvae
47 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla moorei</i> Pemberton, Western Australia	Haploid larvae
48 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla moorei</i> Pemberton, Western Australia	Haploid larvae
49 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla moorei</i> Pemberton, Western Australia	Haploid larvae
50 <i>Hyla aurea</i> cross 41 ♀	<i>Hyla moorei</i> Pemberton, Western Australia	Haploid larvae

BIBLIOGRAPHY

An effort has been made to list all useful references to Australian frogs. References that do not contain information on Australian frogs, but are cited in the text, are marked with an asterisk.

- ABBIE, A. A., AND W. R. ADEY
1950. Motor mechanisms of the Anuran brain. Jour. Comp. Neurol., vol. 92, pp. 241-291.
- AFLALO, FREDERICK G.
1896. A sketch of the natural history of Australia with some notes on sport. London, Macmillan, pp. 191-194.
- AHL, E.
1935. Beschreibung eines neuen Laubfrosches aus Südastralien. Zool. Anz., vol. 109, pp. 252-253.
- AITKEN, A. W.
1870. On the New Zealand frog (*Leiopelma Hochstetteri*), with an account of a remarkable feature in the history of some species of Australian frogs. Trans. New Zealand Inst., vol. 2, pp. 87-88.
- ALEXANDER, W. B.
1922. The vertebrate fauna of Houtman's Abrolhos (Abrolhos Islands), Western Australia. Jour. Linnean Soc. London, Zool., vol. 34, pp. 457-486.
- ANDERSSON, LARS GABRIEL
1931a. Results of Dr. E. Mjöberg's Swedish scientific expeditions to Australia 1910-1913. Bartachians. K. Svenska Vetenskapsakad. Handl., new ser., vol. 52, no. 4, pp. 1-26.
1931b. On a small collection of reptiles and batrachians from German New Guinea and some other herpetological notes. Jahrb. Nassauischen Ver. Naturk., vol. 66, pp. 67-79.
1916. Results of Dr. E. Mjöberg's Swedish scientific expeditions to Australia 1910-1913. Batrachians from Queensland. K. Svenska Vetenskapsakad. Handl., new ser., vol. 52, no. 9, pp. 1-20.
- ANONYMOUS
1883. A list of the vertebrated animals now or lately living in the gardens of the Zoological Society of London. Eighth edition. London, pp. 625-630.
1955. Notes and news (Australian frog flies—*Batrachomyia*). Australian Mus. Mag., vol. 11, pp. 374, 391.
- BALFOUR, FRANCIS MAITLAND
1881. A treatise on comparative embryology. London, Macmillan, vol. 2, p. 115.
- BARBOUR, THOMAS
1914. On some Australasian reptiles. Proc. Biol. Soc. Washington, vol. 27, pp. 201-206.
- BARBOUR, THOMAS, AND A. LOVERIDGE
1929. On some Australian toads of the genus *Pseudophryne*. Copeia, no. 170, pp. 12-15.
- BARRETT, CHARLES
1943. An Australian animal book. Melbourne and London, Oxford University Press, pp. 333-336.
- BELL, THOMAS
1843. Zoology of the voyage of H.M.S. Beagle, under the command of Captain Fitzroy. Part 5. Reptiles. London, Smith, Elder, vi+51 pp.
- BENTLEY, P. J., A. K. LEE, AND A. R. MAIN
1958. Comparison of dehydration and hydration of two genera of frogs (*Heleioporus* and *Neobatrachus*) that live in areas of varying aridity. Jour. Exp. Biol., vol. 35, pp. 677-684.
- BLANCHARD, FRANK N.
1929. Re-discovery of *Crinia tasmaniensis*, with notes on this and other Tasmanian frogs. Australian Zool., vol. 5, pp. 324-328.
- BOEHM, E. F.
1943. Reptiles and amphibians of the Mount Mary Range, S.A. South Australian Nat., vol. 22, no. 1, p. 11.
- BOETTGER, O.
1892. Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main. Frankfurt-am-Main, Knauer, x+73 pp.
1894. Lurche (Batrachia). In Semon, Richard, Zoologische Forschungsreisen in Australiens und dem Malayischen Archipel. Fünfter Band: Systematik, Tiergeographie, Anatomie wirbelloser Tiere. Systematik und Tiergeographie. I Lieferung. Denkschr. Med.-Naturwiss. Gesell. Jena, vol. 8, pp. 107-114.
1901. Die Reptilien und Batrachier. Abhandl. Senckenbergischen Naturf. Gesell., vol. 25, pp. 321-402.
- BOULENGER, GEORGE ALBERT
1882. Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum. Second edition. London, xvi+503 pp.
1885. Remarks on Mr. C. W. De Vis's recent contributions to the herpetology of

- Australia. Ann. Mag. Nat. Hist., ser. 5, vol. 16, pp. 386-387.
1888. Descriptions of two new Australian frogs. *Ibid.*, ser. 6, vol. 2, pp. 142-143.
1890. Description of a new genus of cystignathoid frogs from New South Wales. Proc. Linnean Soc. New South Wales, ser. 2, vol. 5, pp. 593-594.
1893. Description of a new tree-frog from New South Wales. *Ibid.*, ser. 2, vol. 7, p. 403.
1895. Descriptions of a new snake and a new frog from North Australia. Proc. Zool. Soc. London, p. 867.
1897. An account of the reptiles and batrachians collected by Dr. L. Loria in British New Guinea. Ann. Mus. Civ. Storia Nat. Genova, ser. 2, vol. 18, pp. 694-710.
1912. On some tree frogs allied to *Hyla caerulea*, with remarks on noteworthy secondary sexual characteristics in the family Hylidae. Zool. Jahrb., suppl. 15, vol. 1, pp. 211-218.
1914. An annotated list of the batrachians and reptiles collected by the British Ornithologist's Union expedition and the Wollaston expedition in Dutch New Guinea. Trans. Zool. Soc. London, vol. 20, pp. 247-274.
1918. On some Papuan, Melanesian and North-Australian species of the genus *Rana*. Ann. Mag. Nat. Hist., ser. 9, vol. 1, pp. 236-242.
1920. A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. Rec. Indian Mus., vol. 20, pp. 1-226.
- BRACE, E. C., AND OTHERS
1953. The frog *Hyla aurea* as a source of animal parasites. Tuatara, vol. 5, pp. 12-21.
- BRAZENOR, C. W.
1947. A preliminary report on the biology and ecology of the Snowy River area in north-eastern Victoria. Amphibians and reptiles. Mem. Natl. Mus. Victoria, no. 15, pp. 156-158.
- BRIGGS, E. A.
1934. Anatomy of animal types. (Not seen.)
- BROWN, WALTER C.
1952. The amphibians of the Solomon Islands. Bull. Mus. Comp. Zool., vol. 107, no. 1, pp. 1-64.
- BURT, CHARLES E., AND M. D. BURT
1932. Herpetological results of the Whitney South Sea Expedition. VI. Pacific island amphibians and reptiles in the collection of the American Museum of Natural History. Bull. Amer. Mus. Nat. Hist., vol. 63, pp. 461-597.
- BUTLER, W. H., AND BARBARA Y. MAIN
1959. Predation on vertebrates by mygalomorph spiders. Western Australian Nat., vol. 7, p. 52.
- BUXTON, PATRICK A.
1923. Animal life in deserts. A study of the fauna in relation to the environment. London, Edward Arnold, pp. 96-97.
- BUZACOTT, J. H.
1936. How frequently do giant toads produce eggs? Cane Grower's Quart. Bull., vol. 4, p. 5.
- CALABY, J. H.
1956. The food habits of the frog, *Myobatrachus gouldii* (Gray). Western Australian Nat., vol. 5, pp. 93-96.
- CHISHOLM, E. C.
1925. The principal fauna of the Comboyne Plateau, 1923-1925. Australian Zool., vol. 4, pp. 54-74.
1926. Additional fauna of the Comboyne Plateau, 1925-1926. *Ibid.*, vol. 4, pp. 295-298.
1929. Further additional fauna of the Comboyne Plateau, 1926-1928. *Ibid.*, vol. 5, pp. 333-336.
- COLEFAX, A. N.
1956. New information on the corroboree frog (*Pseudophryne corroboree* Moore). Proc. Linnean Soc. New South Wales, vol. 80, pp. 258-266.
- CONDON, H. T.
1941. Further records of lizards and frogs from Kangaroo Island. Rec. South Australian Mus., vol. 7, pp. 111-116.
- COPE, EDWARD D.
1865. Sketch of the primary groups of Batrachia Salientia. Nat. Hist. Rev., 1865, pp. 97-120.
1866. On the structure and distribution of the genera of arciferous Anura. Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, pp. 67-112.
1867. On the families of raniform Anura. *Ibid.*, ser. 2, vol. 6, pp. 189-206.
1869. Seventh contribution to the herpetology of tropical America. Proc. Amer. Phil. Soc., vol. 11, pp. 147-192.
1889. The Batrachia of North America. Bull. U. S. Natl. Mus., vol. 34, p. 312.
- COPLAND, STEPHEN J.
1953. Recent Australian herpetology. Proc. Linnean Soc. New South Wales, vol. 78, pp. v-xxxvii.
1957. Presidential address. Australian tree

- frogs of the genus *Hyla*. *Ibid.*, vol. 82, pp. 9-108.
- DAKIN, WILLIAM J.
1920. Notes on the habits and reproduction of the great western burrowing frog, *Heleioporus albopunctatus*. *Australian Zool.*, vol. 1, pp. 241-244.
- *DARWIN, CHARLES
1859. On the origin of species by means of natural selection or the preservation of favoured races in the struggle for life. London, John Murray, ix+502 pp.
- DAUDIN, FRANÇOIS MARIE
"An. XI" (1802). Histoire naturelles, générale et particulière des reptiles. Paris, Dufart, vol. 8, p. 43.
"An. XI" (1803?). Histoire naturelle des rainettes, des grenouilles et des crapauds. Paris, Levrault, p. 70.
- DAWSON, ALDEN B.
1948. Variations in the number and size of nuclei in the cells of the kidney tubules of an Australian desert frog, *Cyclorana (Chiroleptes) alboguttatus* (Günther). *Anat. Rec.*, vol. 102, pp. 393-407.
1951. Functional and degenerate or rudimentary glomeruli in the kidney of two species of Australian frog, *Cyclorana (Chiroleptes) platycephalus* and *alboguttatus* (Günther). *Ibid.*, vol. 109, pp. 417-430.
- DECKERT, KURT
1929. Import und Nachzucht von *Adelotus brevis* Günther. (Ein neuer australischer Wasserfrosch). *Lacerta*, 1929, no. 5, pp. 17-18.
- DECKERT, RICHARD
1915. Review of two series of amphibians. *Zoologica*, vol. 2, pp. 3-34.
- DUMÉRIL, AUGUSTE
1853. Mémoire sur les batraciens anoures, de la famille des hylaeformes ou rainettes. *Ann. Sci. Nat.*, Paris, ser. 3, vol. 19, Zoologie, pp. 135-179.
1865. Troisième notice sur la Ménagerie des Reptiles du Muséum d'Histoire Naturelle. *Nouv. Arch. Mus. Hist. Nat.*, bull. 1, pp. 31-46.
- DUMÉRIL, A. M. C., AND G. BIBRON
1841. *Erpétologie générale ou histoire naturelle complete des reptiles*. Paris, Roret, vol. 8, ii+792 pp.
1854. [Same title.] Paris, Roret, vol. 9, xx+440+24 pp.
- DUNN, EMMETT R.
1939. Zoological results of the Denison-Crockett Expedition to the South Pacific for the Academy of Natural Sciences of Philadelphia, 1937-1938. Part 2. Amphibia and Reptilia. *Notulae Nat., Acad. Nat. Sci. Philadelphia*, no. 14, pp. 1-2.
- DU TOIT, C. A.
1934. The cranial morphology of *Crinia georgiana* Tschudi (Cystignathidae, Amphibia). *Proc. Zool. Soc. London*, pp. 119-141.
- EMMENS, C. W.
1955. Australian frogs as colourful pets. *Water Life Aquaria World*, vol. 10, pp. 189-190.
- EMMENS, C. W., AND W. L. GERBER
1955. Ein interessanter neuer australischer Frosch. *Aquarien- und Terrarien-Zeitschr.*, vol. 8, pp. 156-158.
- ENGLISH, T. M. SAVAGE
1910. Some notes on Tasmanian frogs. *Proc. Zool. Soc. London*, pt. 2, pp. 627-634.
- FENNER, CHARLES
1955. Frogs and toads. *Walkabout*, vol. 21, p. 20.
- FISCHER, JOH. VON
1883. Der australische Laubfrosch, *Pelodytes coeruleus* (White = *Hyla cyanea* Daudin, in der Gefangenschaft. *Zool. Garten, Zeitschr. Beob., Pflege und Zucht der Tiere*, vol. 24, pp. 21-25.
- FITZINGER, LEOPOLDO J.
1826. Neue Classification der Reptilien nach ihren natürlichen Verwandtschaften. Vienna, Heubner, 66 pp.
1843. *Systema reptilium*. Vienna, Braumüller und Seidel, 106+vi pp.
1861. Die Ausbeute der österreichischen Naturforscher an Säugethieren und Reptilien während der Weltumseglung Sr. Majestät Fregatte Novara. *Sitzber. Math.-Naturwiss. Cl. K. Akad. Wiss. Wien*, vol. 42, pp. 383-416.
- FLEAY, DAVID
1935. Frogs devour snakes. *Victorian Nat.*, vol. 52, pp. 122-123.
1951. Where venomous snake meets carnivorous frog. *Animal Kingdom*, vol. 54, pp. 9-13.
- FLETCHER, J. J.
1889. Observations on the oviposition and habits of certain Australian batrachians. *Proc. Linnean Soc. New South Wales*, ser. 2, vol. 4, pp. 357-387.
1890. Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia. No. 1. *Proc. Linnean Soc. New South Wales*, ser. 2, vol. 5, pp. 667-676.
1891a. Contributions to a more exact knowledge of the geographical distribution

- of Australian Batrachia. No. 2. *Ibid.*, ser. 2, vol. 6, pp. 263-274.
- 1891b. Description of a supposed new cystignathoid frog. *Ibid.*, ser. 2, vol. 6, pp. 275-276.
1892. Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia. No. 3. *Ibid.*, ser. 2, vol. 7, pp. 7-19.
- 1894a. Description of a new cystignathoid frog from New South Wales. *Ibid.*, ser. 2, vol. 8, pp. 522-523.
- 1894b. Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia. No. 4. *Ibid.*, ser. 2, vol. 8, pp. 524-533.
- 1894c. Description of a new cystignathoid frog from New South Wales. *Ibid.*, ser. 2, vol. 8, pp. 229-236.
1898. Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia. No. 5. a. Batrachia of Tasmania. b. Batrachia of West Australia. *Ibid.*, ser. 2, vol. 12, pp. 660-684.
- FRANZ, ELLI
1958. Hat die Larva von *Batrachomyia* in allen Stadien Tentakel? *Senckenbergiana Biol.*, vol. 39, p. 199.
- FRASER, MALCOLM A. C.
1903. Notes on the natural history, etc., of Western Australia, being extracts from the Western Australia Yearbook for 1900-01. Perth, Wm. Alfred Watson, Government Printer, pp. 149-150.
- FROGGATT, WALTER W.
1936. The introduction of the great Mexican toad *Bufo marinus* into Australia. *Australian Nat.*, vol. 9, pp. 163-164.
- FRY, DENE B.
1912. Description of *Austrochaperina*, a new genus of Engystomatidae from north Australia. *Rec. Australian Mus.*, vol. 9, pp. 87-106.
- 1913a. On a *Varanus* and a frog from Burnett River, Queensland, and a revision of the variations in *Limnodynastes dorsalis* Gray. *Ibid.*, vol. 10, pp. 17-34.
- 1913b. A re-examination of Macleay's New Guinea and Queensland frog types. *Mem. Queensland Mus.*, vol. 2, pp. 46-50.
1914. On a collection of reptiles and batrachians from Western Australia. *Rec. Western Australian Mus. and Art Gallery*, vol. 1, pp. 174-210.
1915. Herpetological notes. *Proc. Roy. Soc. Queensland*, vol. 27, pp. 60-95.
1917. Description of *Aphantophryne*, a new batrachian genus from New Guinea. *Proc. Linnean Soc. New South Wales*, vol. 41, pp. 770-785.
- GADOW, HANS
1901. Amphibia and reptiles. In *Cambridge Natural History*. London, Macmillan, xiii+768 pp.
- GARMAN, SAMUEL
1901. Some reptiles and batrachians from Australasia. *Bull. Mus. Comp. Zool.*, vol. 39, pp. 1-14.
- GARNET, J. R.
1959. The Bogong High Plains. *Victorian Nat.*, vol. 76, pp. 213-216.
- GEYER, HANS
1928a. Einiges über *Limnodynastes tasmaniensis*. *Bl. Aquarien- und Terrarien-Kunde*, vol. 39, pp. 195-197.
- 1928b. Beobachtungen über die Entstehung des Schaumnestes bei *Limnodynastes tasmaniensis*. *Ibid.*, vol. 39, pp. 224-225.
- GILLIES, C. D., AND E. F. PEBERDY
1917a. The anatomy of *Hyla caerulea* White. 1. The pectoral girdle and vertebral column. *Proc. Roy. Soc. Queensland*, vol. 29, pp. 45-54.
- 1917b. The anatomy of *Hyla caerulea* White. 2. The skull. *Ibid.*, vol. 29, pp. 117-122.
- GIRARD, CHARLES
1853. Descriptions of new species of reptiles collected by the U. S. Exploring Expedition, under the command of Capt. Charles Wilkes, U.S.N. Second Part. Including the species of batrachians exotic to North America. *Proc. Acad. Nat. Sci. Philadelphia*, vol. 6, pp. 420-424.
1858. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N. Philadelphia, Lippincott, vol. 20, *Herpetology*, xvii+496 pp.
- GLAUERT, L.
1929. Contributions to the fauna of Rottnest Island. *Jour. Roy. Soc. Western Australia*, vol. 15, pp. 37-45.
1945. Some Western Australian frogs. *Australian Mus. Mag.*, vol. 8, pp. 379-382.
1947. Some unfortunate errors in collecting localities. *Western Australian Nat.*, vol. 1, p. 48.
- GRAY, JOHN EDWARD
1835. Mr. Gray exhibited a specimen of a toad. *Proc. Zool. Soc. London*. pt. 3, p. 57.
- 1841a. A catalogue of the species of reptiles and

- Amphibia hitherto described as inhabiting Australia, with a description of some new species from Western Australia, and some remarks on their geographical distribution. In Grey, George, Journals of two expeditions of discovery in north-west and Western Australia during the years 1837, 38, and 39. London, T. and W. Boone, vol. 2, app. E, pp. 422-449.
- 1841b. Description of some new species and four new genera of reptiles from Western Australia, discovered by John Gould, Esq. Ann. Mag. Nat. Hist., vol. 7, pp. 86-91.
1842. Description of some hitherto unrecorded species of Australian reptiles and batrachians. Zool. Misc., pp. 51-57.
1845. Description of some new Australian animals. In Eyre, Edward John, Journals of expeditions of discovery into Central Australia. London, T. and W. Boone, vol. 1, app., pp. 405-407.
1850. [Comments on a letter from H. Schlegel; see Schlegel, 1850.] Proc. Zool. Soc. London, pt. 18, p. 10.
1851. [Comments on a letter from H. Schlegel; see Schlegel, 1851.] Ann. Mag. Nat. Hist., ser. 2, vol. 7, p. 70.
- GRIFFITHS, I.
1954. On the "otic element" in Amphibia Salientia. Proc. Zool. Soc. London, vol. 124, pp. 35-50.
- GÜNTHER, ALBERT
1858. Catalogue of the Batrachia Salientia in the collection of the British Museum. London, xvi+160 pp.
- 1863a. On new species of batrachians from Australia. Ann. Mag. Nat. Hist., ser., 3, vol. 11, pp. 26-28.
- 1863b. Observations on Australian tree-frogs living in the Society's menagerie. Proc. Zool. Soc. London, pp. 249-251.
- 1864a. Third contribution to our knowledge of batrachians from Australia. *Ibid.*, pp. 46-49.
- 1864b. Third contribution to our knowledge of batrachians from Australia. Ann. Mag. Nat. Hist., ser. 3, vol. 14, pp. 311-315.
1867. Additions to the knowledge of Australian reptiles and fishes. *Ibid.*, ser. 3, vol. 20, pp. 45-68.
- 1868a. First account of species of tailless batrachians added to the collection of the British Museum. Proc. Zool. Soc. London, pp. 478-490.
- 1868b. Batrachia Salientia. Zool. Rec., for 1867, vol. 4, pp. 142-148.
1870. Second account of the species of tailless batrachians added to the collection of the British Museum. Proc. Zool. Soc. London, pp. 401-402.
1873. Description of two new species of frogs from Australia. Ann. Mag. Nat. Hist., ser. 4, vol. 11, pp. 349-350.
1876. Descriptions of new species of reptiles from Australia. Jour. Mus. Godeffroy, vol. 5, pt. 12, pp. 45-47.
1897. Description of new species of lizards and of a tree-frog from north-eastern Queensland. Novitates Zool., vol. 4, pp. 403-406.
- GUIBÉ, JEAN
- (1950?) Catalogue des types d'amphibiens du Muséum National d'Histoire Naturelle. Paris, 71 pp.
1953. Les batraciens et les reptiles des régions Indo-Malaise et Australo-Neoguineenne. Compt. Rendu Somm. Seances Soc. Biogeogr., no. 257, pp. 2-5.
- HARRISON, LAUNCELOT
1921. Notes on the pigmentation of frog's eggs. Proc. Linnean Soc. New South Wales, vol. 46, pp. 370-373.
1922. On the breeding habits of some Australian frogs. Australian Zool., vol. 3, pp. 17-34.
1927. Notes on some Western Australian frogs, with descriptions of new species. Rec. Australian Mus., vol. 15, pp. 277-287.
- *HEDLEY, C.
1894. The faunal regions of Australia. Rept. 5th Meeting Australasian Assoc. Adv. Sci., Adelaide, South Australia, September, 1893 (vol. 5), pp. 444-446.
- HESSE, ERWIN
1932. Über den Laichakt bei *Limnodynastes tasmaniensis*. Bl. Aquarien- und Terrarien-Kunde, vol. 43, p. 315.
- HEWER, A. M.
1951. A new discovery in the Tasmanian amphibians. Tasmanian Nat., new ser., vol. 2, no. 2, pp. 33-34.
- HILL, J. P.
1894. Note on an abnormal connection of the renal-portals in a young male frog (*Limnodynastes peronii*). Proc. Linnean Soc. New South Wales, ser. 2, vol. 8, pp. 222-224.
- HILL, W. C. O.
1954. Report of the Society's prosector for the year 1953. Proc. Zool. Soc. London, vol. 124, pp. 303-311.
- *HINDWOOD, K. A., AND A. R. MCGILL
1958. The birds of Sydney. Sydney, Royal

- Zoological Society of New South Wales, 128 pp.
- HOFFMAN, A. C.
1931. On the general anatomy of the genus *Heleophryne*. South African Jour. Sci., vol. 28, pp. 399-407.
- HOSMER, WILLIAM
1958. A note on the identity of *Heleioporus sudelli* Lamb. North Queensland Nat., no. 121, pp. 1-2.
- JACQUINOT, HONORÉ, AND M. A. GUICHENOT
1853. Reptiles et poissons. In Dumont-d'Urville, M. J., Voyage au Pole Sud et dans l'Océanie. Paris, Zoologie, vol. 3, pp. 25-28.
- *JOHNSON, CLIFFORD
1959. Genetic incompatibility in the call races of *Hyla versicolor* LeConte in Texas. Copeia, pp. 327-335.
- JOHNSTON, S. J.
1912. On some trematode-parasites of Australian frogs. Proc. Linnean Soc. New South Wales, vol. 37, pp. 285-362.
- JONES, E. IDRIS
1933. Observations on the pectoral musculature of Amphibia Salientia. Ann. Mag. Nat. Hist., ser. 10, vol. 12, pp. 403-420.
- KAMPEN, P. N. VAN
1906. Amphibien. Nova Guinea, vol. 5, pp. 163-180.
1909. Die Amphibienfauna von Neu-Guinea, nach der ausbeute der Niederländischen Süd-Neu-Guinea-Expeditionen von 1904-1905 und 1907. *Ibid.*, vol. 9, pp. 31-49.
1913. Amphibien, gesammelt von der Niederländischen Süd-Neu-Guinea-Expedition von 1909-10. *Ibid.*, vol. 9, pp. 453-465.
1914. Zur Fauna von Nord-Neuguinea. Nach den Sammlungen von Dr. P. N. van Kampen und K. Gjellerup aus den Jahren 1910 und 1911. Amphibien. Zool. Jahrb. Abt. Syst., vol. 37, pp. 365-378.
1915. Amphibien von Neu-Guinea. (Südwest-Neu-Guinea-Expedition 1912/13). Nova Guinea, vol. 13, pp. 39-41.
1923. The Amphibia of the Indo-Australian Archipelago. Leiden, E. J. Brill, xii + 304 pp.
- *KEAST, ALLEN
1959. The reptiles of Australia. In Keast, Allen, and others (eds.), Biogeography and ecology in Australia. The Hague, W. Junk, pp. 115-135.
- KEFERSTEIN, WILH.
1867. Ueber einige neue oder seltene Batrachier aus Australien und dem tropischen Amerika. Nachr. K. Gesell. Wiss. Georg-Augusta Univ., Göttingen, no. 18, pp. 341-361.
- 1868a. Ueber die Batrachier Australiens. Arch. Naturgesch., vol. 34, pp. 253-290.
1868b. Beschreibung einiger neuen Batrachier aus Australien und Costarica. Nachr. K. Gesell. Wiss. Georg-Augusta-Univ., Göttingen, no. 15, pp. 326-332.
- KESTIVEN, H. L.
1944. The evolution of the skull and the cephalic muscles. A comparative study of their development and adult morphology. Part 2, the Amphibia. Mem. Australian Mus., vol. 8, pp. 133-236.
- *KEY, K. H. L.
1959. The ecology and biogeography of Australian grasshoppers and locusts. In Keast, Allen, and others (eds.), Biogeography and ecology in Australia. The Hague, W. Junk, pp. 192-210.
- KINGHORN, J. R.
1924. Reptiles and batrachians from south and south-west Australia. Rec. Australian Mus., vol. 14, pp. 163-183.
1931. Herpetological notes. No. 2. *Ibid.*, vol. 18, pp. 85-91.
1932. Herpetological notes. No. 4. *Ibid.*, vol. 18, pp. 355-363.
1935. Reptiles and amphibians from Princess Charlotte Bay, North Queensland. Rec. South Australian Mus., vol. 5, p. 366.
1938. The giant toad *Bufo marinus* in Australia. Australian Mus. Mag., vol. 6, pp. 410-411.
1944. Frogs and toads. *Ibid.*, vol. 8, pp. 271-276.
1945. The Simpson Desert Expedition, 1939. 3. Reptiles and amphibians. Trans. Roy. Soc. South Australia, vol. 69, pp. 3-9.
1956. Introducing frogs and toads. Australian Mus. Mag., vol. 12, pp. 40-43.
- KLINGENBÖFFER, WILHELM
1931. Terrarienkunde. Stuttgart, Julius Wagner.
1956. Terrarienkunde. Teil 2, Lurche. Stuttgart, Alfred Kernen, 236 pp.
- KREFFT, GERHARD
1862. On the Vertebrata of the Lower Murray and Darling, their habits, economy and geographical distributions. Trans. Phil. Soc. New South Wales, 1862-1865, pp. 1-33.
1863. On the batrachians occurring in the neighbourhood of Sydney, with remarks upon their geographical distribution. Proc. Zool. Soc. London, pp. 386-390.

1864. Notes on the metamorphosis of a dipterous insect of the genus *Batrachomyia* (MacLeay) the larva of which is parasitical upon various species of Australian frogs. *Trans. Ent. Soc. New South Wales*, vol. 1, pp. 100-101.
1865. The frogs of Australia. *Papers Proc. Roy. Soc. Tasmania*, pp. 16-20.
1867. Australian Vertebrata (recent and fossil), representing all the genera known up to the present time. *In* Catalogue of the natural and industrial products of New South Wales forwarded to the Paris Universal Exhibition of 1867. Sydney, Government Printer, pp. 107-109.
1869. Notes on the fauna of Tasmania. *Papers Proc. Roy. Soc. Tasmania*, for 1868, appendix, pp. 91-105.
1870. Australian Vertebrata—fossil and recent. Batrachian reptiles. *In* The industrial progress of N.S.W., being a report of the Intercolonial Exhibition of 1870, at Sydney, pp. 741-748.
- LAMB, J.
1911. Description of three new batrachians from southern Queensland. *Ann. Queensland Mus.*, no. 10, pp. 26-28.
- LANKES, K.
1909. Einige Bemerkungen über den Korallenfinger (*Hyla coerulea* White). *Bl. Aquarien- und Terrarien-Kunde*, vol. 20, pp. 182-184.
1928. Zur Biologie des Korallenfingers (*Hyla caerulea* [J. White]). *Ibid.*, vol. 39, pp. 6-7.
- LEE, A. K., AND A. R. MAIN
1954. Two new species of burrowing frogs of the genus *Heliophorus* Gray from southwestern Australia. *Western Australian Nat.*, vol. 4, pp. 156-158.
- LESSON, R. P.
1830. Voyage autour du monde, . . . sur la corvette de la majeste, La Coquille. Paris, Arthus Bertrand, *Zoologie*, vol. 2, pp. 59-61.
- LINDNER, ERWIN
1958. *Batrachomyia mertensi*, ein neuer australischer Froschparasit (Chloropidae, Dipt.). *Senckenbergiana Biol.*, vol. 39, pp. 191-196.
- LITTLEJOHN, MURRAY J.
1957. A new species of frog of the genus *Crinia*. *Western Australian Nat.*, vol. 6, pp. 18-23.
1958. A new species of frog of the genus *Crinia* Tschudi from south-eastern Australia. *Proc. Linnean Soc. New South Wales*, vol. 83, pp. 222-226.
1959. Call differentiation in a complex of seven species of *Crinia* (Anura, Leptodactylidae). *Evolution*, vol. 13, pp. 452-468.
- LITTLEJOHN, MURRAY J., AND A. R. MAIN
1959. Call structure in two genera of Australian burrowing frogs. *Copeia*, pp. 266-270.
- LÖNNBERG, EINAR
1900. Reptiles and amphibians collected in German New Guinea by the late Dr. Erik Nyman. *Ann. Mag. Nat. Hist.*, ser. 7, vol. 6, pp. 574-582.
- LORD, CLIVE E., AND H. H. SCOTT
1924. A synopsis of the vertebrate animals of Tasmania. Hobart, Oldham, Beddome, and Meredith, 340 pp.
- LOVERIDGE, ARTHUR
1933a. Four new crinine frogs from Australia. *Occas. Papers Boston Soc. Nat. Hist.*, vol. 8, pp. 55-60.
- 1933b. A new genus and three new species of crinine frogs from Australia. *Ibid.*, vol. 8, pp. 89-94.
1934. Tasmanian Amphibia in the Museum of Comparative Zoology, Cambridge, Massachusetts. *Papers Proc. Roy. Soc. Tasmania*, for 1933, pp. 56-64.
1935. Australian Amphibia in the Museum of Comparative Zoology, Cambridge, Massachusetts. *Bull. Mus. Comp. Zool.*, vol. 78, pp. 1-60.
1938. On some reptiles and amphibians from the central region of Australia. *Trans. Roy. Soc. South Australia*, vol. 62, pp. 183-191.
1945. Reptiles of the Pacific world. New York, Macmillan Co., xii + 259 pp.
1948. New Guinean reptiles and amphibians in the Museum of Comparative Zoology and the United States National Museum. *Bull. Mus. Comp. Zool.*, vol. 101, pp. 305-430.
1949. On some reptiles and amphibians from the Northern Territory. *Trans. Roy. Soc. South Australia*, vol. 72, pp. 208-215.
1950. New frogs of the genera *Cyclorana* and *Hyla* from southeastern Australia. *Proc. Biol. Soc. Washington*, vol. 63, pp. 131-138.
1956. Rediscovery of *Hyla dorsalis* and *Lechriodus papuanus* in New Guinea. *Breviora* (Mus. Comp. Zool.), no. 55, pp. 1-4.
- LUCAS, A. H. S.
1892. Notes on the distribution of Victorian batrachians, with descriptions of two

- new species. Proc. Roy. Soc. Victoria, new ser., vol. 4, pp. 59-64.
1897. On some facts in the geographical distribution of land and fresh-water vertebrates in Victoria. *Ibid.*, new ser., vol. 9, pp. 34-53.
- LUCAS, A. H. S., AND W. H. D. LE SOUËF
1909. The animals of Australia. Mammals, reptiles, and amphibians. Melbourne, Whitcombe and Tombs, xi+327 pp.
- LÜTKEN, CHR.
1863. Nogle nye krybdyr og padder. Vidensk. Meddel. Naturhist. For. Kjöbenhavn, for 1862, pp. 292-311.
- LUTHER, WOLFGANG
1933. Über den Nestbau von *Lymanodynastes tasmaniensis*. Bl. Aquarien- und Terrarien-Kunde, vol. 44, pp. 362-363.
- MCCOY, FREDERICK
1867. On the recent zoology and palaeontology of Victoria. Ann. Mag. Nat. Hist., ser. 3, vol. 20, pp. 175-202.
1880. Natural history of Victoria. Prodomus of the zoology of Victoria. Melbourne, George Robertson, decade 5, pp. 11-13.
1881. [Same title.] Melbourne, George Robertson, decade 6, pp. 13-17.
- MACKAY, R. D.
1955. Notes on a collection of reptiles and amphibians from the Furneaux Islands, Bass Strait. Australian Zool., vol. 12, pp. 160-164.
- McKEOWN, K. C.
1943. Vertebrates captured by Australian spiders. Proc. Roy. Zool. Soc. New South Wales, for 1942-1943, pp. 17-30.
- MACLEAY, WILLIAM
1877. The batrachians of the "Chevert" expedition. Proc. Linnean Soc. New South Wales, vol. 2, pp. 135-138.
- *MCMICHAEL, DONALD F., AND TOM IREDALE
1959. The land and freshwater Mollusca of Australia. In Keast, Allen, and others (eds.), Biogeography and ecology in Australia. The Hague, W. Junk, pp. 224-245.
- MAIN, ALBERT R.
1954a. Key to the frogs of south-western Australia. Western Australian Nat., vol. 4, pp. 114-124.
1954b. Report on excursions. Helena Gorge. *Ibid.*, vol. 4, pp. 169-170.
1954c. Distribution of frogs in Australia. Proc. Pan-Indian Ocean Sci. Congr. Western Australia, sect. B and D, pt. 1, p. 2.
1957a. Studies in Australian Amphibia. 1. The genus *Crinia* Tschudi in south-western Australia and some species from south-eastern Australia. Australian Jour. Zool., vol. 5, pp. 30-55.
1957b. A new burrowing frog from Western Australia. Western Australian Nat., vol. 6, pp. 23-24.
- MAIN, ALBERT R., AND J. H. CALABY
1957. New records and notes on the biology of frogs from north-western Australia. Western Australian Nat., vol. 5, pp. 216-228.
- MAIN, ALBERT R., A. K. LEE, AND M. J. LITTLEJOHN
1958. Evolution in three genera of Australian frogs. Evolution, vol. 12, pp. 224-233.
- MAIN, ALBERT R., M. J. LITTLEJOHN, AND A. K. LEE
1959. Ecology of Australian frogs. In Keast, Allen, and others (eds.), Biogeography and ecology in Australia. The Hague, W. Junk, pp. 396-411.
- MAIN, BARBARA Y., AND A. R. MAIN
1956. Spider predator on a vertebrate. Western Australian Nat., vol. 5, p. 139.
- MANDEVILLE, L. C.
1952. Golden tree frogs. Aquarist, vol. 16, p. 202.
- MARRINER, GEORGE R.
1907. On the presence of another Australian frog in New Zealand. Trans. Proc. New Zealand Inst., 1906, vol. 39, pp. 144-149.
- *MAYR, ERNST
1948. The bearing of the new systematics on genetical problems. The nature of species. Advances Genet., vol. 2, pp. 205-237.
- *MAYR, ERNST, E. G. LINSLEY, AND R. L. USINGER
1953. Methods and principles of systematic zoology. New York, McGraw-Hill, vii + 328 pp.
- MÉHELY, LAJOS
1901. Beiträge zur Kenntniss der Engystomalen von Neu-Guinea. Termész. Füzt., vol. 24, pp. 169-271.
- MERREM, BLASIUS
1820. Versuch eines Systems amphibien. Marburg, Krieger, xv+191 pp.
- MERTENS, ROBERT
1930a. Die von Dr. F. Kopstein auf den Molukken und einigen Benachbarten inseln gesammelten Froschlurche. Zool. Meded. Rijks Mus. Nat. Hist. Leiden, vol. 13, pp. 141-150.
*1930b. Die Amphibien und Reptilien der inseln Bali, Lombok, Sumbawa und Flores. Abhandl. Senckenbergischen Naturf. Gesell., vol. 42, pt. 3, pp. 115-344.

- 1958a. Quer durch Australien. Frankfurt, Waldemar Kramer, 200 pp.
- 1958b. Ergänzende Bemerkungen über *Batrachomyia*-larven und ihre Wirte. Senckenbergiana Biol., vol. 39, pp. 197-198.
- 1958c. Als Zoologie in Australien. 3. Im Herzen des fünften Kontinents. Natur und Volk, vol. 88, pp. 264-276.
- MITCHELL, FRANCIS J.
1955. Preliminary account of the Reptilia and Amphibia collected by the National Geographic-Commonwealth Government-Smithsonian Institution Expedition to Arnhem Land (April to November, 1948). Rec. South Australian Mus., vol. 11, pp. 373-408.
- MOORE, JOHN A.
- *1946. Incipient intraspecific isolating mechanisms in *Rana pipiens*. Genetics, vol. 31, pp. 304-326.
1953. A new species of *Pseudophryne* from Victoria. Proc. Linnean Soc. New South Wales, vol. 78, pp. 179-180.
- 1954a. Geographic and genetic isolation in Australian Amphibia. Amer. Nat., vol. 88, pp. 65-74.
- 1954b. Geographic and genetic isolation in Australian Amphibia. Caryologia, vol. 6, suppl., pp. 888-889.
1955. Abnormal combinations of nuclear and cytoplasmic systems in frogs and toads. Advances Genet., vol. 7, pp. 139-182.
1956. A rejoinder to Rabb and Mosimann's letter. Amer. Nat., vol. 90, pp. 390-392.
- 1957a. Frogs of the Sydney region. Australian Mus. Mag., vol. 12, pp. 212-216.
- 1957b. An embryologist's view of the species problem. In Mayr, Ernst (ed.), The species problem. Publ. Amer. Assoc. Adv. Sci., no. 50, pp. 325-338.
1958. A new genus and species of leptodactylid frog from Australia. Amer. Mus. Novitates, no. 1919, pp. 1-7.
1959. Hybridization as an adjunct to the systematics of amphibians. Proc. XV Internatl. Congr. Zool., London, pp. 117-119.
- MÜLLER, EDMUND
1932. Untersuchungen über die Mundhöhlendrüsen der anuren Amphibien. Morph. Jahrb., vol. 70, pp. 131-172.
- MÜLLER, LORENZ
1901. Der australische Korallenfinger (*Hyla caerulea*). Bl. Aquarien- und Terrarien-Kunde, vol. 12, pp. 71-75.
- MÜLLER, W.
1951. Über Pflege und Zucht von *Limnodynastes tasmaniensis*. Aquarien Terrarien Zeitschr., Stuttgart, vol. 4, pp. 272-273.
- MUNGOMERY, R. W.
1935. The giant American toad (*Bufo marinus*). Queensland Agr. Jour., vol. 44, pp. 242-248. (Not seen.)
1936. Sex reversal in the giant toad. Cane Grower's Quart. Bull., vol. 4, p. 7. (Not seen.)
- MURRAY, P. D. F.
1926. The development of the frog from the tadpole. Australian Nat., vol. 6, pp. 42-44.
- NICHOLLS, GEORGE E.
1916. The structure of the vertebral column in the Anura Phaneroglossa and its importance as a basis of classification. Proc. Linnean Soc. London, vol. 128, pp. 80-92.
- NIEDEN, FR.
1923. Anura 1. In Apstein, C. (ed.), Das Tierreich. Berlin and Leipzig, Walter de Gruyter, no. 46, xxxii+584 pp.
1926. Anura 2. In Apstein, C. (ed.), Das Tierreich. Berlin and Leipzig, Walter de Gruyter, no. 49, xiii+110 pp.
- NOBLE, G. KINGSLEY
1922. The phylogeny of the Salientia. Bull. Amer. Mus. Nat. Hist., vol. 46, pp. 1-87.
- *1929. The adaptive modifications of aboreal tadpoles of *Hoplophryne* and the torrent tadpoles of *Staurois*. Ibid., vol. 58, pp. 291-334.
1931. The biology of the Amphibia. New York, McGraw-Hill, xiii+577 pp.
- OERTTER, JOSEF
1955. Australische Buntkröten. Aquarien Terrarien Zeitschr., Stuttgart, vol. 8, pp. 298-299.
- OESER, R.
1934. Weitere Zuchterfolge bei exotischen Fröschen. Bl. Aquarien- und Terrarien-Kunde, vol. 45, pp. 352-355.
1954. Froschzuchten nach dem Kriege. Aquarien Terrarien Zeitschr., Stuttgart, vol. 7, pp. 157-159.
- OGILBY, J. DOUGLAS
1907. A new tree frog from Brisbane. Proc. Roy. Soc. Queensland, vol. 20, pp. 31-32.
- OLIVER, KATHLEEN K.
1909. The structure of the truncus arteriosus in species of the genera *Hyla*, *Limnodynastes*, *Chiroleptes*, *Heleioporus*, *Pseudophryne*, and *Notaden*. Proc. Roy. Soc. Victoria, vol. 22, pp. 198-208.
- ORMSBY, A. I.
1957. Notes on the giant toad (*Bufo marinus*). Proc. Roy. Zool. Soc. New South Wales, for 1955-1956, pp. 54-55.

- *PARAMONOV, S. J.
1959. Zoogeographical aspects of the Australian Diptero fauna. In Keast, Allen, and others (eds.), Biogeography and ecology in Australia. The Hague, W. Junk, pp. 164-191.
- PARKER, H. W.
1926. New reptiles and a new frog from Queensland. Ann. Mag. Nat. Hist., ser. 9, vol. 17, pp. 665-670.
1934. A monograph of the frogs of the family Microhylidae. London, British Museum (Natural History), viii+208 pp.
1936. A collection of reptiles and amphibians from the mountains of British New Guinea. Ann. Mag. Nat. Hist., ser. 10, vol. 17, pp. 66-93.
1938. The races of the Australian frog *Hyla aurea* Lesson. *Ibid.*, ser. 11, vol. 2, pp. 302-305.
1940. The Australasian frogs of the family Leptodactylidae. Novitates Zool., vol. 42, pp. 1-106.
- PARKER, WILLIAM K.
1881. On the structure and development of the skull in the Batrachia. Part III. Phil. Trans. Roy. Soc. London, vol. 172, pp. 1-266.
- PETERS, W.
1863. Übersicht der von Hrn. Richard Schomburgk an das zoologische Museum eingesandten Amphibien, aus Buchsfelde bei Adelaide in Südastralien. Monatsber. K. Preussischen Akad. Wiss. Berlin, 1863, pp. 228-236.
1867. Herpetologische Notizen. *Ibid.*, 1867, pp. 13-37.
1869. Machte eine Mittheilung über neue Saurier (*Chaunoloemus multicastratus*, *Tropidolepisma Richardi*, und *Gymnodactylus Steudneri*) und Batrachier (*Cyclorhampus fasciatus* und *Hyla gracilentus*). *Ibid.*, 1869, pp. 786-790.
1871. Über einige Arten der herpetologischen Sammlung des Berliner Zoologischen Museum. *Ibid.*, 1871, p. 648.
1873a. Über zwei Giftschlangen aus Afrika und über oder weniger bekannte Gattungen und Arten von Batrachiern. *Ibid.*, 1873, pp. 411-418.
1873b. Über eine neue Schildkrötenart, *Cinosternon Effeldtii* und einige andere neue oder weniger bekannte Amphibien. *Ibid.*, 1873, pp. 603-618.
1875. Las über neue Amphibien. *Ibid.*, 1874, pp. 616-624.
1881. Über neue oder weniger bekannte Amphibiens Berliner Zoologischen Museums. *Ibid.*, 1880, pp. 217-224.
- PETERS, W., AND G. DORIA
1878. Catalogo dei rettili e dei batraci raccolti da O. Beccari, L. M. D'Albertis e A. A. Bruijn nella sotto-regione Austromalese. Genoa, 130 pp.
- PHILIPP, G. A.
1958. *Myobatrachus gouldii* in the coastal hills near City Beach. Western Australian Nat., vol. 6, pp. 131-132.
- *POLLISTER, ARTHUR W., AND JOHN A. MOORE
1937. Tables for the normal development of *Rana sylvatica*. Anat. Rec., vol. 68, pp. 489-496.
- PROCTER, JOAN B.
1921. On the variation of the scapula in the batrachian groups Aglossa and Arcifera. Proc. Zool. Soc. London, pp. 197-214.
1923. On new and rare reptiles and batrachians from the Australian region. *Ibid.*, pp. 1069-1077.
1924. Unrecorded characters seen in living snakes, and description of a new tree-frog. *Ibid.*, pp. 1125-1129.
- RABB, GEORGE B., AND JAMES E. MOSIMANN
1956. Taxonomic criteria in Australian frogs. Amer. Nat., vol. 90, pp. 388-390.
- RAHECEK, W.
1926. *Limnodynastes tasmaniensis* Gthr., seine Pflege und Zucht. Bl. Aquarien- und Terrarien-Kunde, vol. 37, pp. 120-122.
- RICHARDSON, L. R.
1947. Second report on herniation in *Hyla aurea*. Copeia, pp. 255-258.
- ROSS, E. CLUNIES
1908a. Observations on frogs. Australian Nat., vol. 1, pp. 129-131.
1908b. Notes on the genus *Pseudophryne*. *Ibid.*, vol. 1, pp. 145-148.
- ROTH, H. LING
1908. The discovery and settlement of Port Mackay, Queensland. Halifax, F. King, viii+114 pp.
- ROUX, JEAN
1910. Reptilen und Amphibien der Aru- und Kei-Inseln. Abhandl. Senckenbergischen Naturf. Gesell., vol. 33, pp. 211-247.
1920. Note sur la présence du genre *Crinia*, amphibien cystignathide, en Nouvelle-Guinée. Rev. Suisse Zool., vol. 28, pp. 115-117.
- SANGER, E. B.
1883. Note on the occurrence of two genera of Branchipoda in the Australian desert. Amer. Nat., vol. 17, p. 1185.
- SCHLEGEL, HERMAN
1837-1844. Abbildungen neuer oder unvollständig bekannter Amphibien, nach der Natur oder dem Leben entworfen. Düsseldorf, Arnz, p. 26.

1850. Description of a new genus of batrachians from Swann River. *Proc. Zool. Soc. London*, pt. 18, pp. 9-10.
1851. Description of a new genus of batrachians from Swan River. *Ann. Mag. Nat. Hist.*, ser. 2, vol. 7, p. 70.
1858. Handleiding tot de beoeffening der dierkunde. *Handleid. Dierk.*, vol. 2, pp. 59, 545. (Not seen.)
- SCHMIDT, ALFRED
1952. *Hyla coerulea* White. *Aquarien Terrarien Zeitschr.*, Stuttgart, vol. 5, pp. 241-243.
- SCHNEIDER, JOHANANN GOTTLÖB
1799. *Historiae amphibiorum. Fasciculus primus*. Jena, Frommani, xiii+374 pp.
- SCORTECCI, GIUSEPPE
1953. *Animali*. Milan, Labor, vol. 5, pp. 177, 194.
- SCOTT, E. O. G.
1942. A new *Hyla* from Cradle Valley, Tasmania. *Rec. Queen Victoria Mus., Launceston*, vol. 1, pp. 5-11.
- *SERVENTY, D. L., AND H. M. WHITTELL
1951. A handbook of the birds of Western Australia (with the exception of the Kimberley Division). Second edition. Perth, Paterson Brokenska, pp. 44-60.
- SHAW, GEORGE
1795. [No title.] *Nat. Misc.*, vol. 6, pl. 200.
1802. General zoology, or systematic natural history. London, vol. 3, pt. 1, pp. 112-113.
- SIMONS, JOHN R., AND A. R. MICHAELIS
1953. A cinematographic technique, using ultra-violet illumination, for amphibian blood circulation. *Nature*, vol. 151, p. 801.
- SKUSE, FREDERICK A. A.
1889. Description of a new genus (*Batrachomyia*, W. S. MacLeay, MS.), and two species of dipterous insects parasitic upon Australian frogs. *Proc. Linnean Soc. New South Wales*, ser. 2, vol. 4, pp. 171-177.
- SLATER, J. W.
1890. Notes on the natural history of Queensland. *Harwicke's Sci.-Gossip*, vol. 26, pp. 36-37.
- SLATER, P., AND E. LINDGREN
1955. A visit to Queen Victoria Spring, January, 1955. *Western Australian Nat.*, vol. 5, pp. 10-18.
- SLEVIN, JOSEPH R.
1955. Notes on Australian amphibians. *Proc. California Acad. Sci.*, vol. 28, pp. 355-392.
- SMITH, MALCOLM A.
1929. *Amphibia*. In *List of the vertebrated animals exhibited in the gardens of the Zoological Society of London, 1829-1927*. London, vol. 3, pp. 275-309.
- SPENCER, BALDWIN
1892. The fauna and zoological relationships of Tasmania. *Rept. 4th Meeting Australasian Assoc. Adv. Sci. Hobart, Tasmania*, January, 1892, pp. 82-124.
- *1896a. Report of the work of the Horn Scientific Expedition to Central Australia. Part 1. Introduction, narrative, summary of results, supplement to zoological report, map. London, Dulau, pp. 196-199.
- 1896b. Report on the work of the Horn Scientific Expedition to Central Australia. London, Dulau, pt. 2, *Amphibia*, pp. 152-175.
1901. Two new species of frogs from Victoria. *Proc. Roy. Soc. Victoria*, new ser., vol. 13, pp. 175-178.
- SPENCER, BALDWIN, AND F. J. GILLEN
1912. *Across Australia*. London, Macmillan Co., vol. 1, pp. i-xiv, 1-254; vol. 2, pp. i-xvii, 255-515.
- *STARRETT, PRISCILLA
1960. Descriptions of tadpoles of Middle American frogs. *Misc. Publ. Mus. Zool. Univ. Michigan*, no. 110.
- STEEL, THOMAS
1912. A remarkable burrowing frog. *Australian Nat.*, vol. 2, p. 135.
- STEINDACHNER, FRANZ
1868. Über eine neue *Hylorana*-Art von Cap-York in Australien. *Sitzber. Math. Nat. Cl. K. Akad. Wiss. Wien*, vol. 57, pt. 1, pp. 532-536.
- "1869" (1867). *Amphibien*. In *Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857-1859*. Vienna, *Zoologische Theil*, vol. 1, pt. 4, pp. 1-70.
- STERNFELD, RICHARD
1925. Beiträge zur Herpetologie inner-Australiens. *Abhandl. Senckenbergischen Naturf. Gesell.*, vol. 38, pp. 221-251.
- STIRLING, E. C., AND A. ZIETZ
1893. *Amphibia* (collected by the Elder Exploring Expedition.) *Trans. Roy. Soc. South Australia*, vol. 16, p. 176.
- SWEET, GEORGIANA
1897. On the variations in the spinal nerves of *Hyla aurea*. *Proc. Roy. Soc. Victoria*, new ser., vol. 9, pp. 264-296.
1908. The anatomy of some Australian Amphibia. A. The openings of the nephrostomes from the coelom. B. The connections of the vasa efferentia with the kidney. *Ibid.*, new ser., vol. 20, pp. 222-249.

*TATE, RALPH

1889. On the influence of physiographic changes in the distribution of life in Australia. Rept. 1st Meeting Australasian Assoc. Adv. Sci., Sydney, New South Wales, August and September, 1888, pp. 312-325.

TAYLOR, EDWARD H.

1935. Notes on a small herpetological collection from Western Australia. Trans. Kansas Acad. Sci., vol. 38, pp. 341-344.

- *1954. Frog-egg-eating tadpoles of *Anothea coronata* (Stejneger) (Salientia, Hylidae). Univ. Kansas Sci. Bull., vol. 36, pp. 589-596.

THOMAS, I. M.

1958. Some notes on the fauna of South Australia. In Best, Rupert, J. (ed.), Introducing South Australia. Adelaide, Australian and New Zealand Association for the Advancement of Science, p. 119.

TREWAVAS, ETHELWYNN

1933. The hyoid and larynx of the Anura. Phil. Trans. Roy. Soc. London, pt. B, vol. 222, pp. 401-527.

TSCHUDI, J. J.

- "1839" (1838). Classification der Batrachier, mit Berücksichtigung der fossilen Thiere dieser Abtheilung der Reptilien. Mém. Soc. Sci. Nat. Neuchatel, vol. 2, pp. 30-75.

VIS, CHARLES W. DE

- 1884a. On some new batrachians from Queensland. Proc. Linnean Soc. New South Wales, vol. 9, pp. 65-67.

- 1884b. On new species of *Hyla*. Proc. Roy. Soc. Queensland, vol. 1, pp. 128-130.

WAGLER, JOHANN GEORG

1830. Natürliches System der Amphibien, mit vorangehender Classification der Säugthiere und Vögel. Munich, Cotta'schen, p. 200.

WAITE, EDGAR R.

1925. Field notes on some Australian reptiles and batrachians. Rec. South Australian Mus., vol. 3, pp. 17-32.

1927. The fauna of Kangaroo Island, South Australia. No. 3. The reptiles and amphibians. Trans. Roy. Soc. South Australia, vol. 51, pp. 326-329.

1929. The reptiles and amphibians of South Australia. Adelaide, Harrison Weir, 270 pp.

WATSON, J. A. L., AND L. M. SAUNDERS

1959. Observations on the reproductive system of the female of *Myobatrachus gouldii* (Gray). Western Australian Nat., vol. 7, pp. 1-6.

WEINGAND, K.

1927. Eine Krankheitserscheinung bei *Limno-*

dynastes tasmaniensis. Bl. Aquarien-Terrarienkunde, vol. 38, pp. 64-65.

1928. Etwas von *Limnodynastes tasmaniensis*. *Ibid.*, vol. 39, p. 30.

WERNER, FRANZ

1893. Herpetologische nova. Zool. Anz., vol. 16, pp. 81-84.

- 1897a. Über einige noch Unbeschriebene reptilien und batrachier. *Ibid.*, vol. 20, pp. 261-267.

- 1897b. Bemerkungen über einige *Hyla*-Arten des Zoologischen Museums in München. Sitzber. Math.-Phys. Cl. K. Akad. Wiss. München, vol. 27, pp. 215-220.

1901. Beschreibung neuer Frösche aus Bolivia, Ostindien und Neu-Guinea. Zool. Anz., vol. 24, pp. 97-103.

1914. Amphibia. In Michaelsen, W., and R. Hartmeyer, Die Fauna Südwest-Australiens. Jena, Gustav Fischer, vol. 4, pp. 403-426.

WHITE, JOHN

1790. Journal of a voyage to New South Wales, with sixty-five plates of non-descript animals, birds, lizards, serpents, curious cones of trees and other natural productions. London, Bebbett, p. 248.

WHITE, S. R.

1950. Notes on the breeding of the giant burrowing frog at Coorow. Western Australian Nat., vol. 2, pp. 136-137.

WHITLEY, G. P.

1947. The fluvi-faunulae of Australia. Western Australian Nat., vol. 1, pp. 49-53.

WITTE, GASTON-FR. DE

1930. Résultats scientifiques du voyage aux Indes Orientales Néerlandaises batraciens. Mém. Mus. Roy. d'Hist. Nat. Belgique, hors ser., vol. 5, fasc. 1, pp. 3-8.

WOLTERSTORFF, W.

- 1926a. Zur Weiterzuchtung des *Limnodynastes tasmaniensis* Gthr. Bl. Aquarien- und Terrarienkunde, vol. 37, p. 402.

- 1926b. Bemerkungen über *Limnodynastes tasmaniensis* Günther und seine Fortpflanzung. *Ibid.*, vol. 37, pp. 463-464.

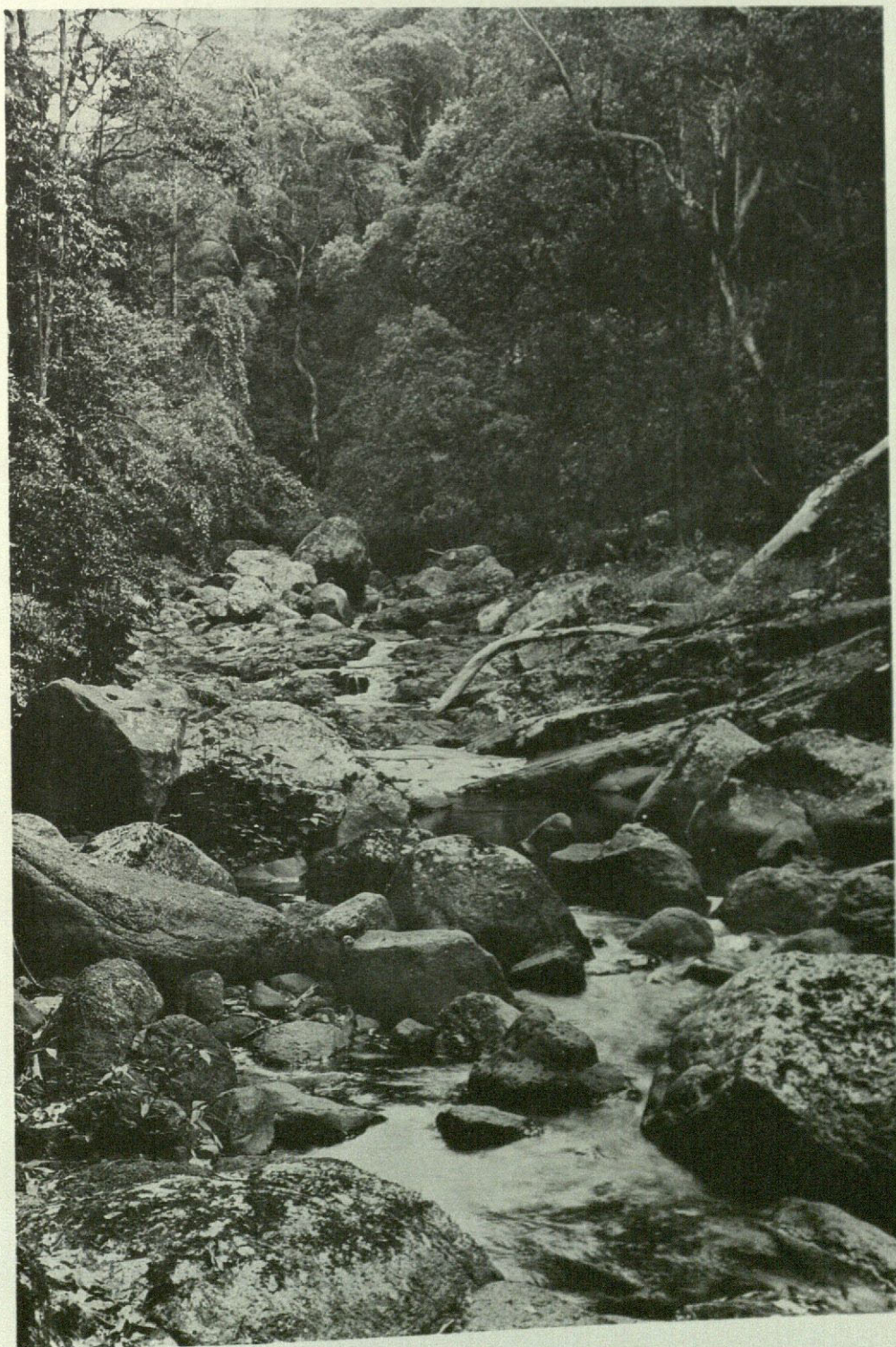
ZERNECKE, E.

1926. Über Haltung und Zucht des *Limnodynastes tasmaniensis*. Bl. Aquarien- und Terrarienkunde, vol. 37, pp. 465-467.

ZWEIFEL, RICHARD G.

1956. Results of the Archbold Expeditions. No. 72. Microhylid frogs from New Guinea, with descriptions of new species. Amer. Mus. Novitates, no. 1766, pp. 1-49.

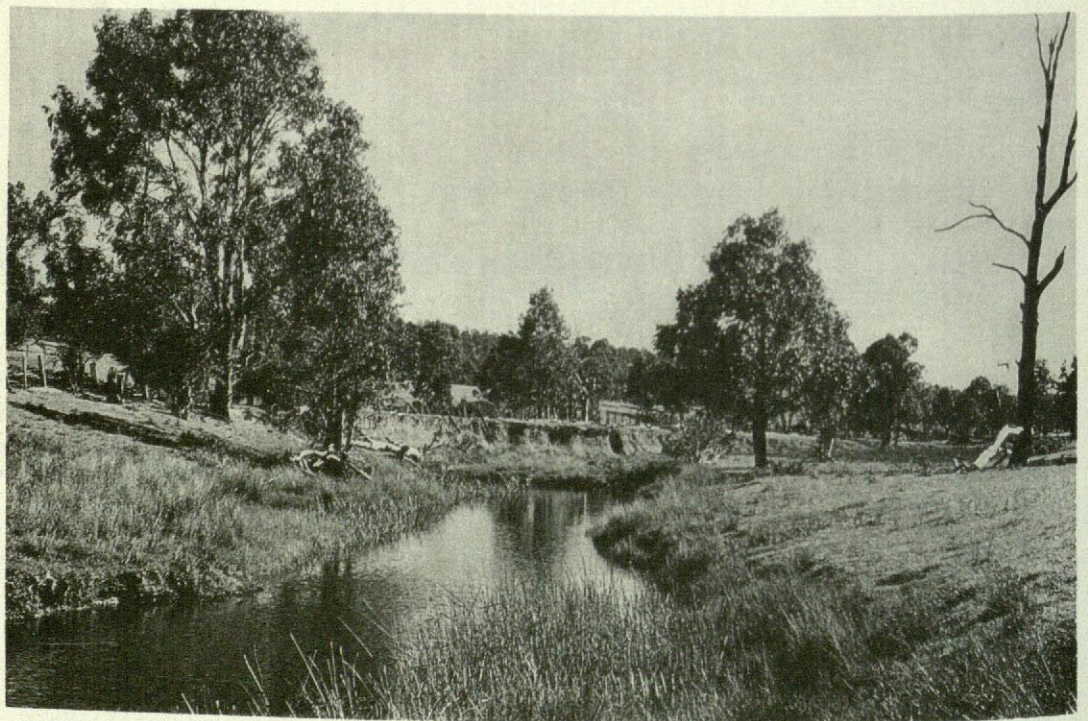
1958. Results of the Archbold Expeditions. No. 78. Frogs of the Papuan hylid genus *Nyctimystes*. *Ibid.*, no. 1896, pp. 1-51.



Coomera River, Binna Burra, Queensland. Habitat of *Mixophyes fasciolatus*, *Adelotus brevis*, and *Lechriodus fletcheri*

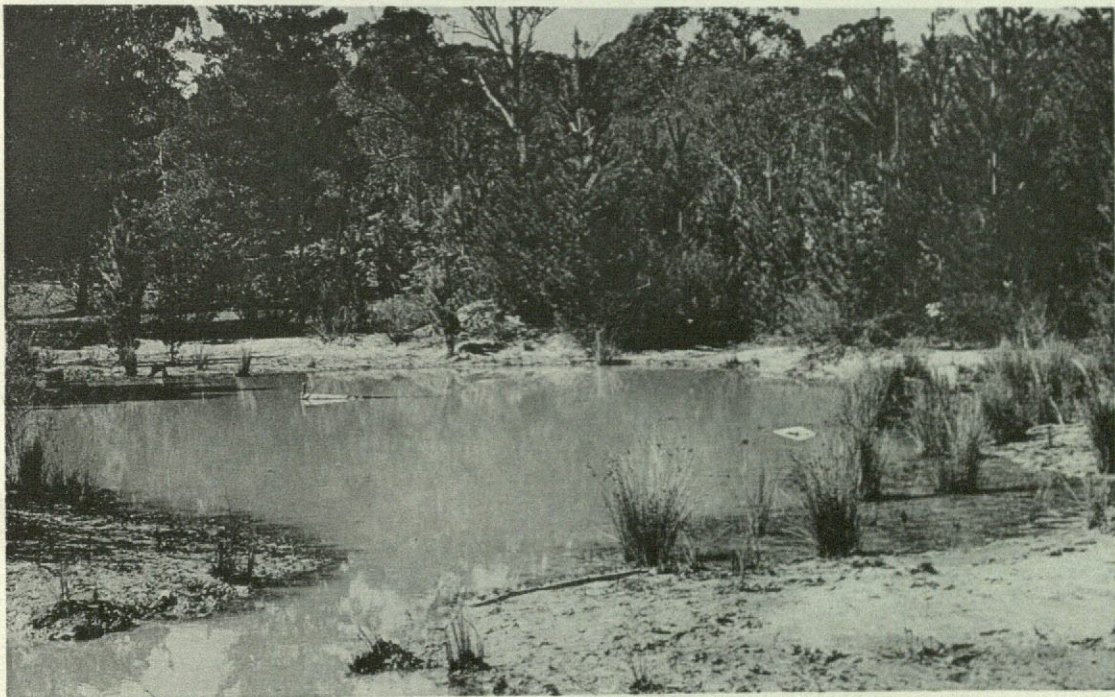


1

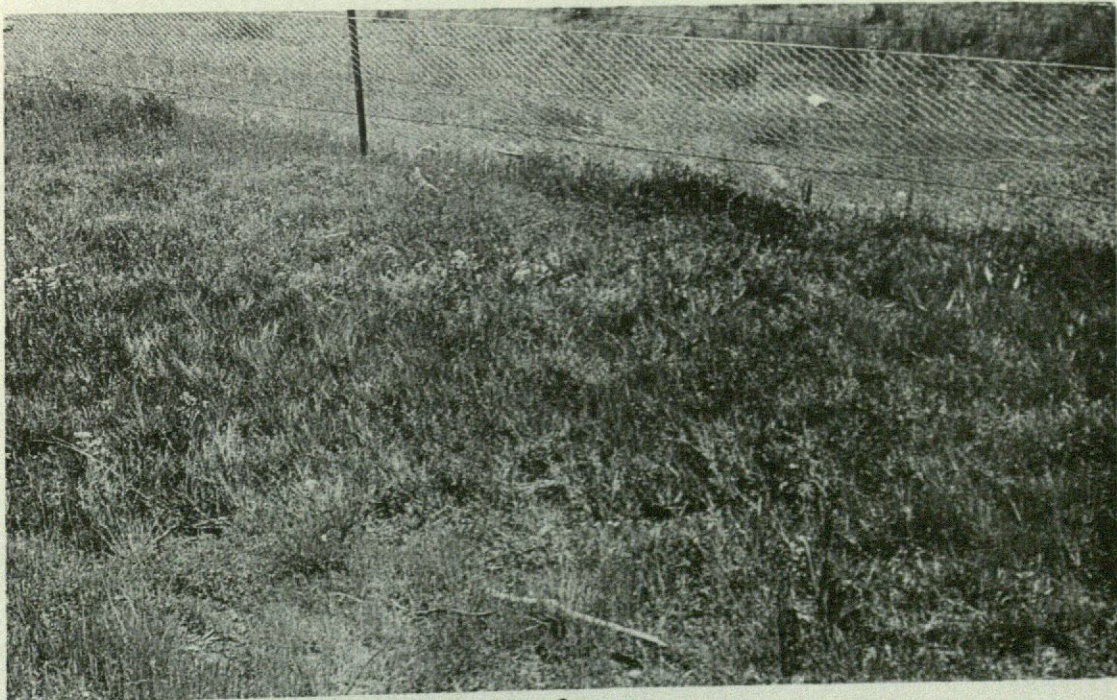


2

1. Guy Fawkes Creek, Ebor, New South Wales. Habitat of *Adelotus brevis*, *Limnodynastes tasmaniensis*, *Limnodynastes peroni*, *Crinia signifera*, *Pseudophryne bibroni*, *Hyla aurea*, *Hyla phyllochroa*, *Hyla ewingi*, *Hyla peroni*, and *Hyla booroolongensis*
2. Booroolong Creek, near Armidale, New South Wales. Habitat of *Limnodynastes tasmaniensis*, *Limnodynastes dorsalis*, *Pseudophryne bibroni*, *Hyla aurea*, *Hyla ewingi*, and *Hyla booroolongensis*



1



2

1. Pond at Burradoo, New South Wales. Habitat of *Crinia signifera*, *Limnodynastes dorsalis*, *Limnodynastes tasmaniensis*, *Hyla ewingi*, *Hyla aurea* and *Pseudophryne bibroni* (nearby)

2. Mt. Stromlo, Australian Capital Territory. Grassy marsh where *Neobatrachus pictus* was found breeding



1. Sphagnum bog near Point Lookout, Ebor, New South Wales. Breeding site and type locality for *Kyarranus sphagnicolus*
2. Uralla Lagoon, Uralla, New South Wales. Habitat of *Limnodynastes tasmaniensis*, *Limnodynastes fletcheri*, *Uperoleia marmorata*, and *Hyla ewingi*

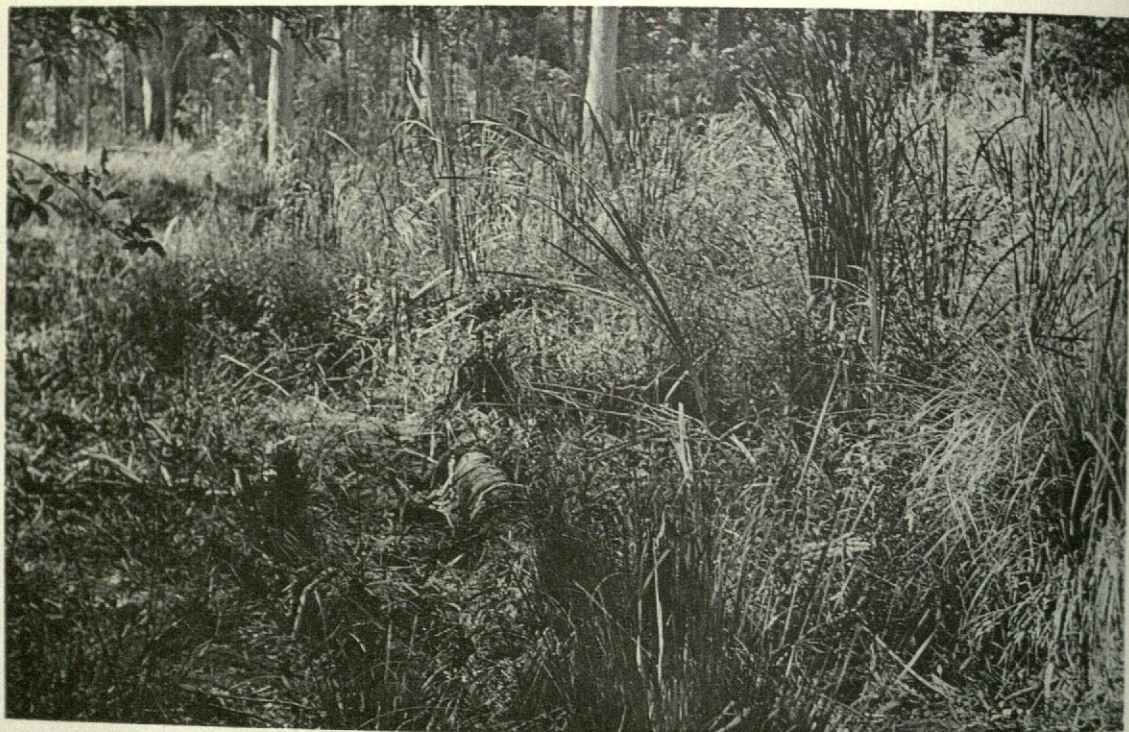


1



2

1. Rainsby Station, near Aramac, Queensland. Estivating site for *Limnodynastes ornatus*
2. Lake Albina, Mt. Kosciusko, New South Wales. Habitat of *Hyla ewingi* and *Crinia signifera*

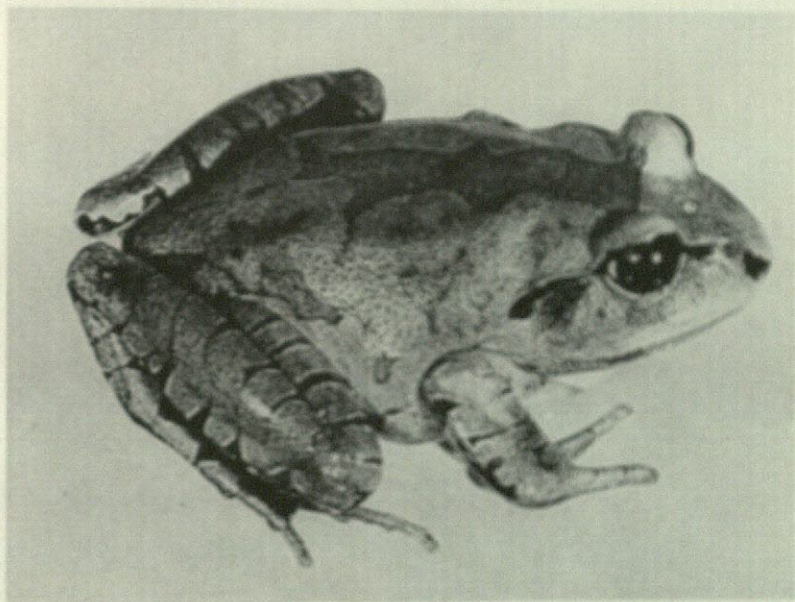


1



2

1. Swamp at Binna Burra, Queensland. Habitat of *Adelotus brevis*, *Hyla peroni*, *Hyla ewingi*, and *Hyla ?lesueuri* (possibly *vinosa*)
2. Lawler's Creek, near Bodalla, New South Wales. *Hyla jervisiensis*, *Hyla ewingi*, *Hyla phyllochroa*, *Pseudophryne dendyi*, and *Crinia signifera* were found here



1

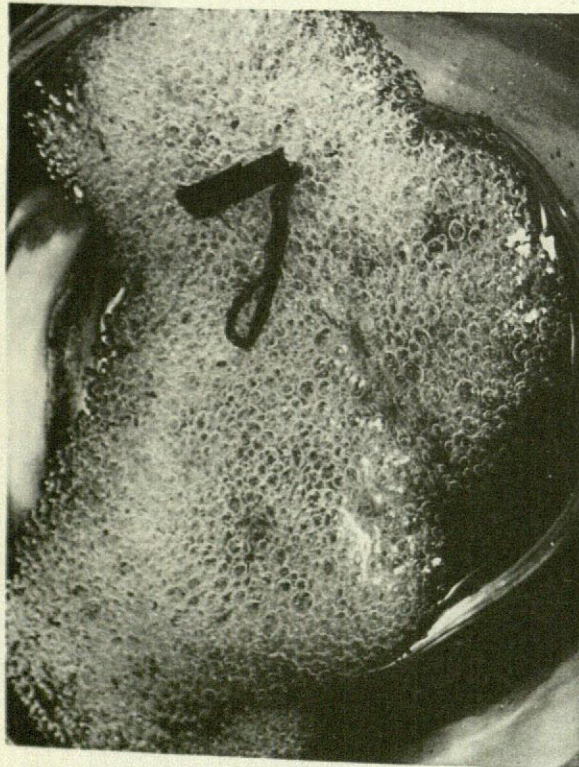


2

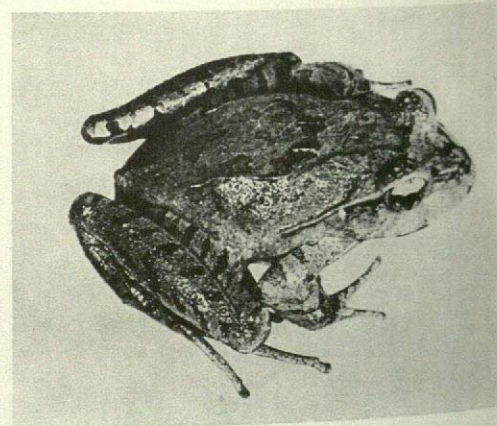
1. *Mixophyes fasciolatus* (A.M.N.H. No. 58862); Binna Burra, Queensland
2. *Cyclorana australis*; Rainaby Station, near Aramac, Queensland
Both natural size



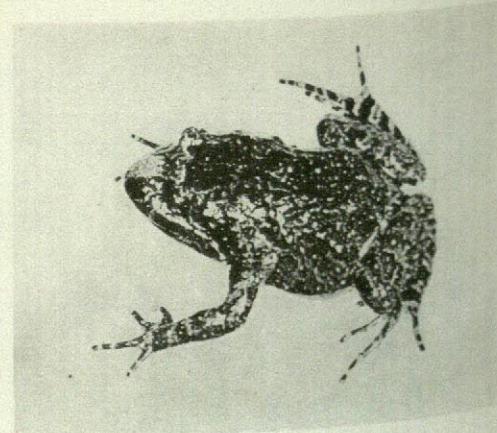
1



2

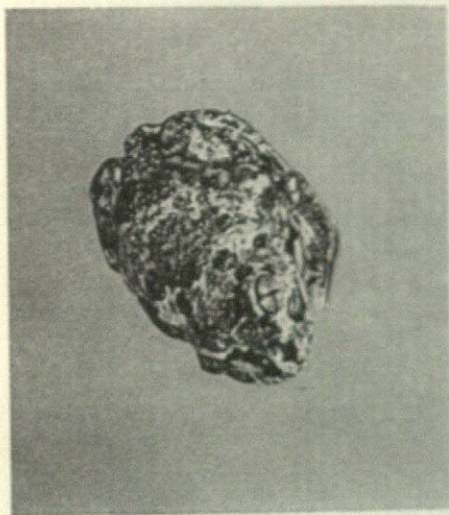


3

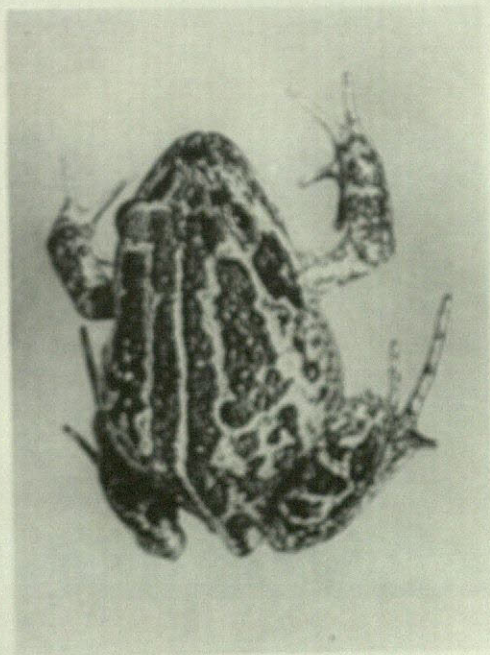


4

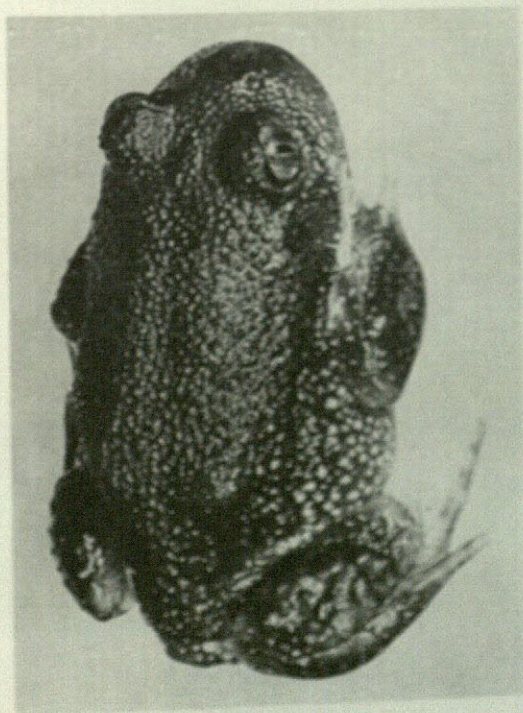
1. *Cyclorana alboguttatus*; Rainsby Station, near Aramac, Queensland
 2. *Adelotus brevis*, egg mass; Ebor, New South Wales
 3. *Lechriodus fletcheri* (A.M.N.H. No. 58953); Binna Burra, Queensland
 4. *Adelotus brevis*; Ebor, New South Wales
- All natural size



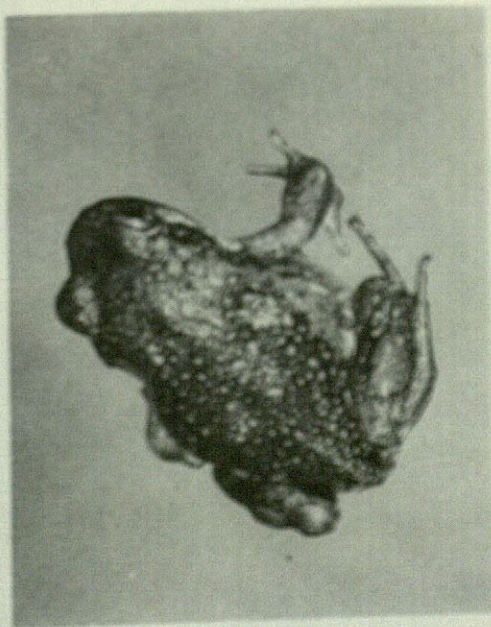
2



4



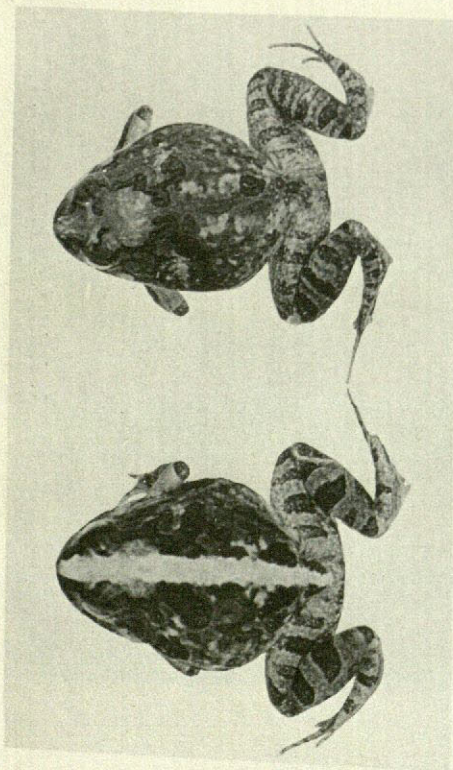
1



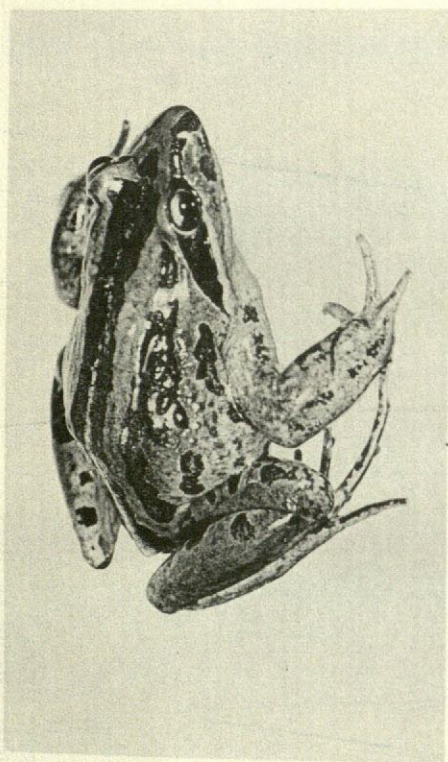
3

1. *Helicophrynus australiacus*; Killara, New South Wales
2. *Neobatrachus pictus*; Mt. Stromlo, Australian Capital Territory
- 3, 4. *Limnodynastes dorsalis*. 3. Burradoo, New South Wales. 4. Cann River, Victoria

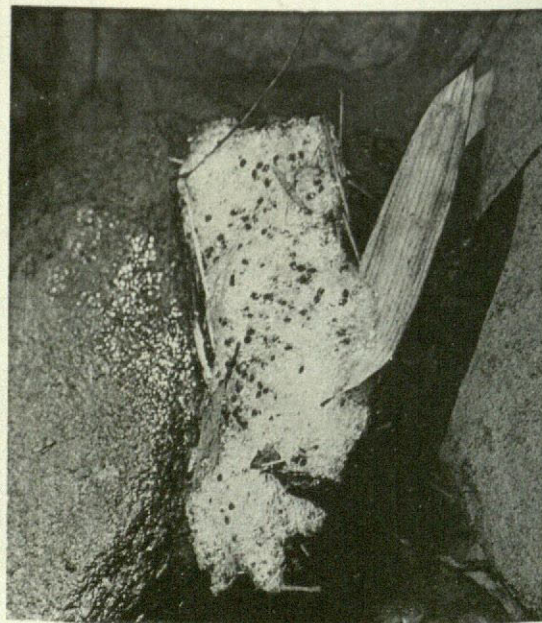
All natural size



1



2



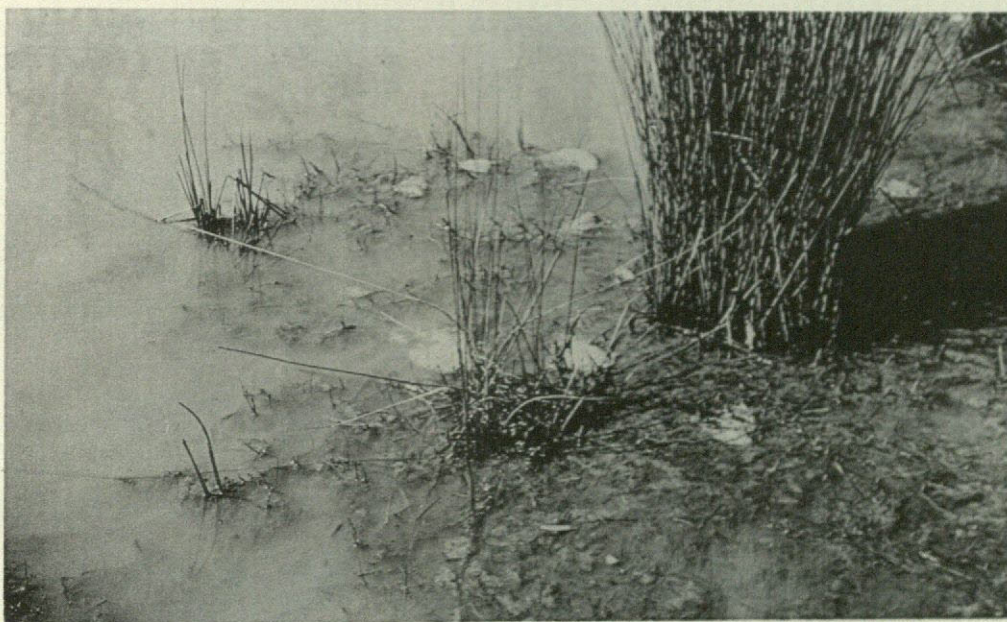
3



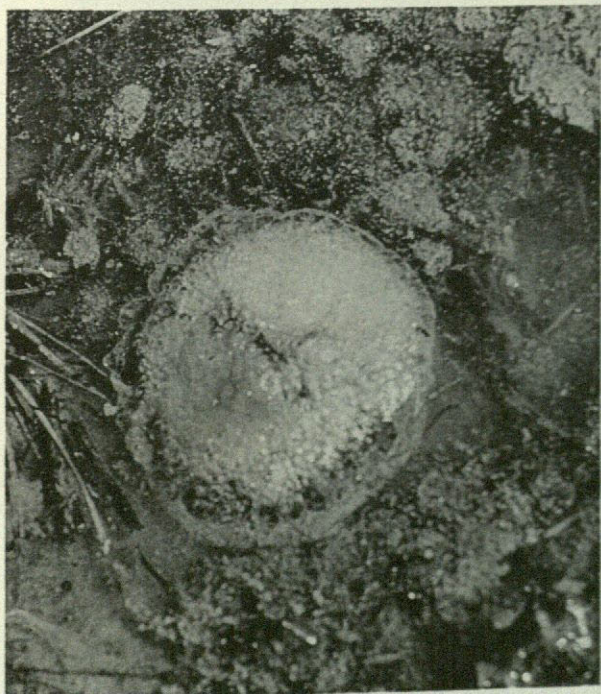
4

1. *Limnodynastes ornatus*; Rainsby Station, near Aramac, Queensland
- 2-4. *Limnodynastes peroni*. 2. Killara, New South Wales. 3. Egg mass; Killara, New South Wales. 4. Rockdale, New South Wales

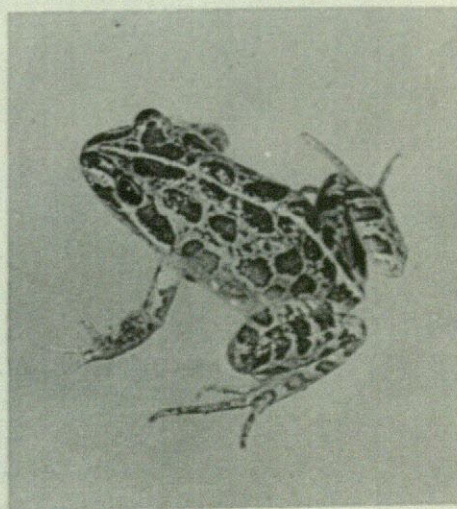
All except 3 natural size



1

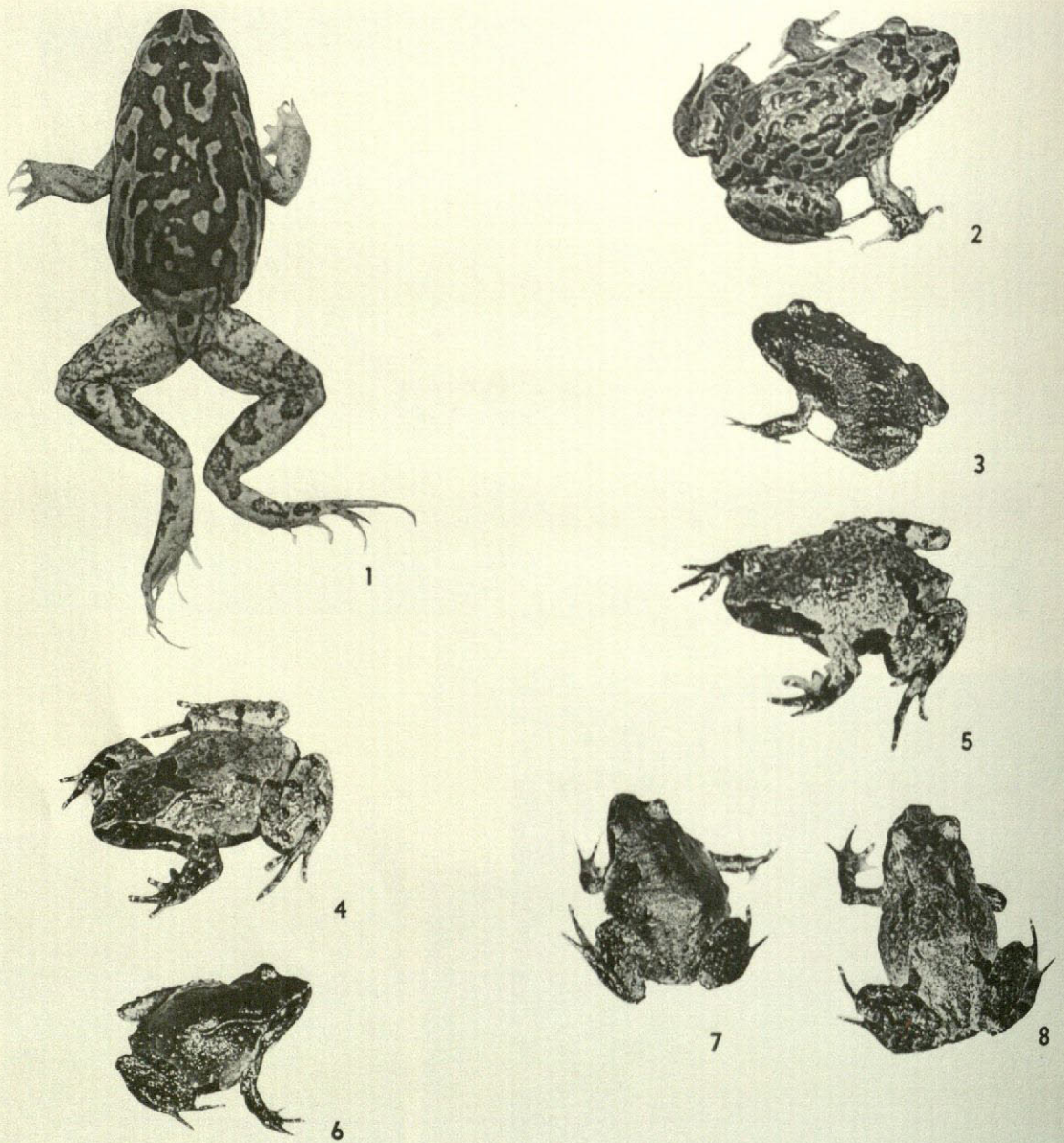


2



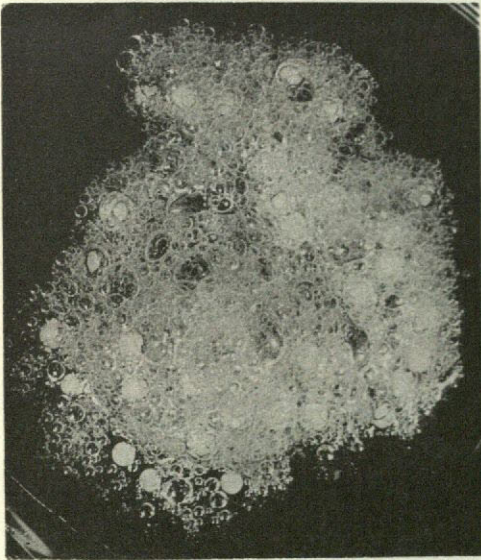
3

1-3. *Limnodynastes tasmaniensis*. 1, 2. Egg masses; Burradoo, New South Wales. 3. Burradoo, New South Wales; natural size



1. *Limnodynastes fletcheri* (A.M.N.H. No. 60637); near Boggabilla, New South Wales
2. *Limnodynastes salmini*; St. Lawrence, Queensland
3. *Uperoleia marmorata*; Glenbrook, New South Wales
- 4, 5. *Kyarranus sphagnicolus*; Point Lookout, near Ebor, New South Wales
- 6, 7. *Kyarranus loveridgei*; Binna Burra, Queensland
8. *Kyarranus sphagnicolus*; Point Lookout, near Ebor, New South Wales

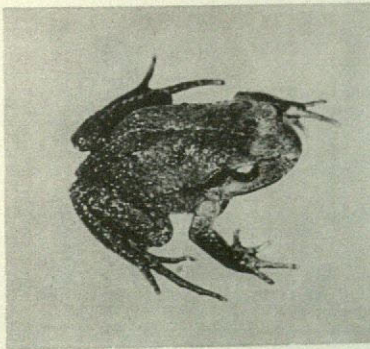
All natural size



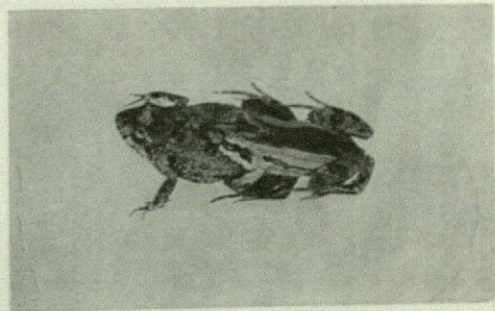
1



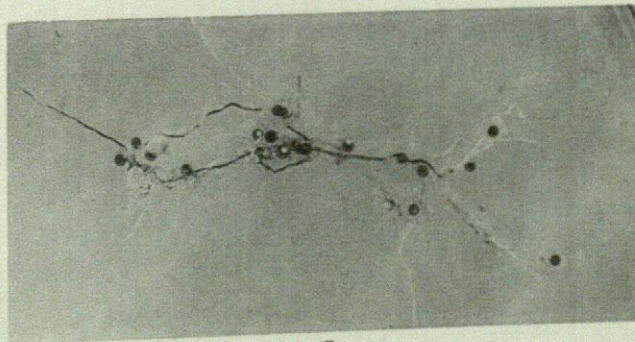
2



3

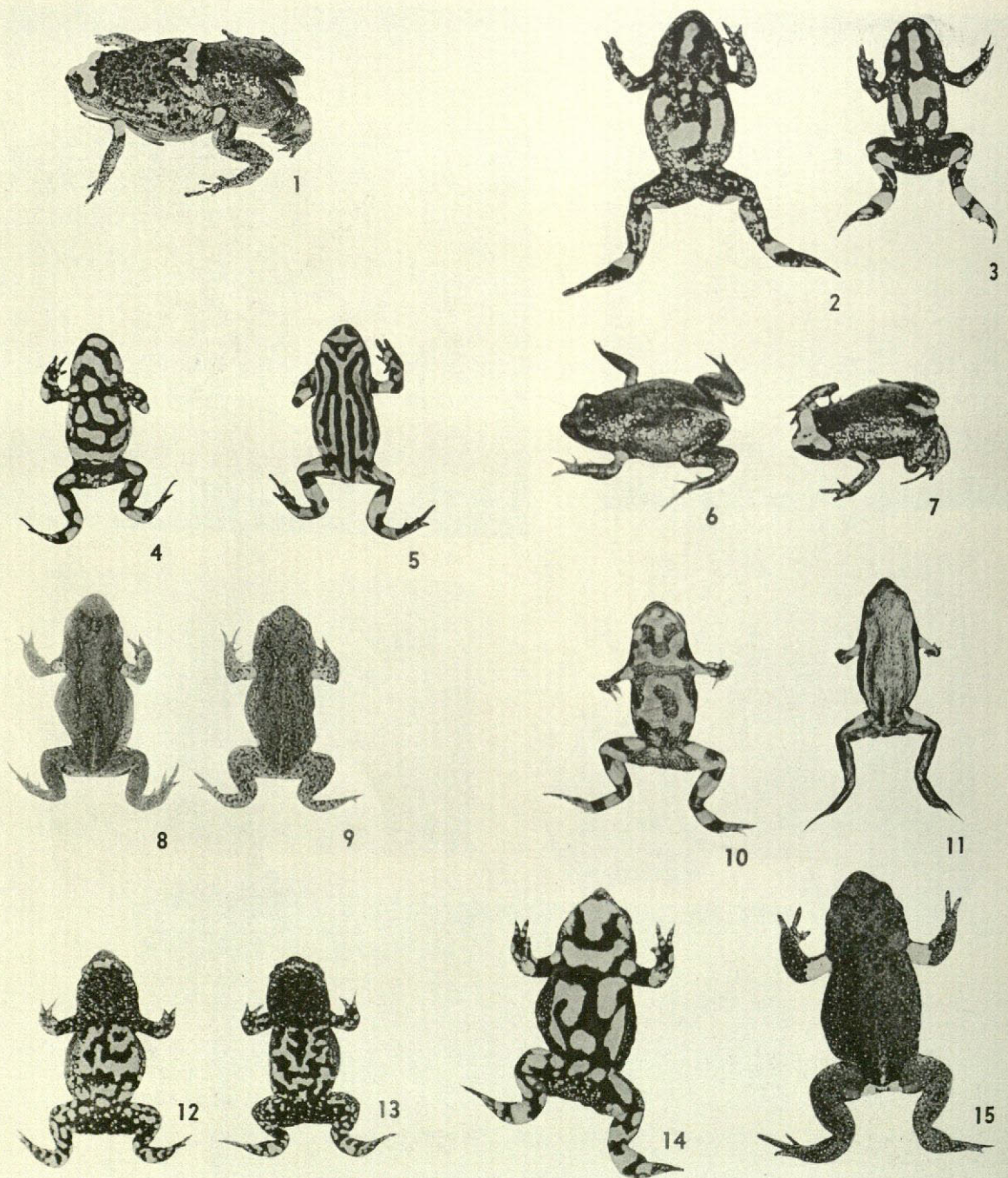


4

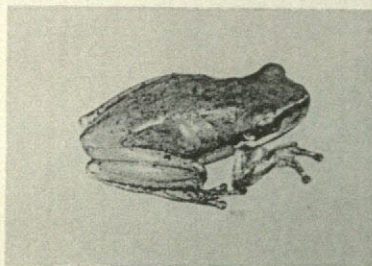


5

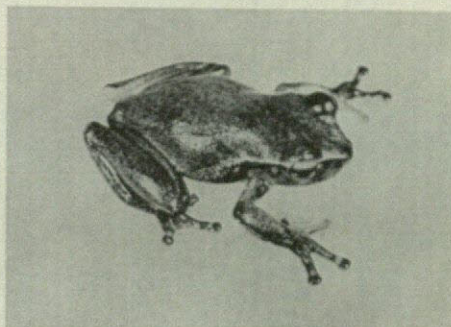
1. *Kyarranus sphagnicolus*, egg mass; Point Lookout, near Ebor, New South Wales
 2. *Kyarranus loveridgei*, nest; Binna Burra, Queensland
 3. *Crinia haswelli*; Cann River, Victoria
 4, 5. *Crinia signifera*. 4. Mating pair; Killara, New South Wales. 5. Embryos; Killara, New South Wales
 All natural size



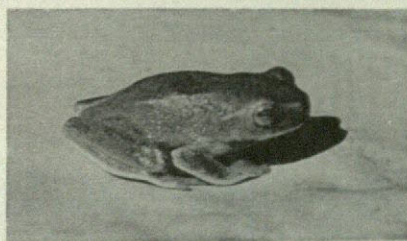
- 1-3. *Pseudophryne australis*. 1. Clasp pair; National Park, New South Wales. 2, 3. Ventral views; Killara, New South Wales
 4, 5. *Pseudophryne corroboree*, type (Australian Museum No. 13103). 4. Ventral view. 5. Dorsal view
 6. *Pseudophryne bibroni*; Burradoo, New South Wales
 7. *Pseudophryne australis*; National Park, New South Wales
 8, 9. *Pseudophryne bibroni*, dorsal views; Killara, New South Wales
 10, 11. *Pseudophryne coriacea*. 10. A.M.N.H. No. 65198, ventral view; Horton's Creek, near Nymboida, New South Wales. 11. A.M.N.H. No. 65196, dorsal view; Hickey's Creek, near Bellbrook, New South Wales
 12, 13. *Pseudophryne bibroni*, ventral views of individuals shown in 8 and 9
 14, 15. *Pseudophryne dendyi*; Dynamite Creek, 15 miles from Orbost, Victoria. 14. Ventral view. 15. Dorsal view
 All natural size



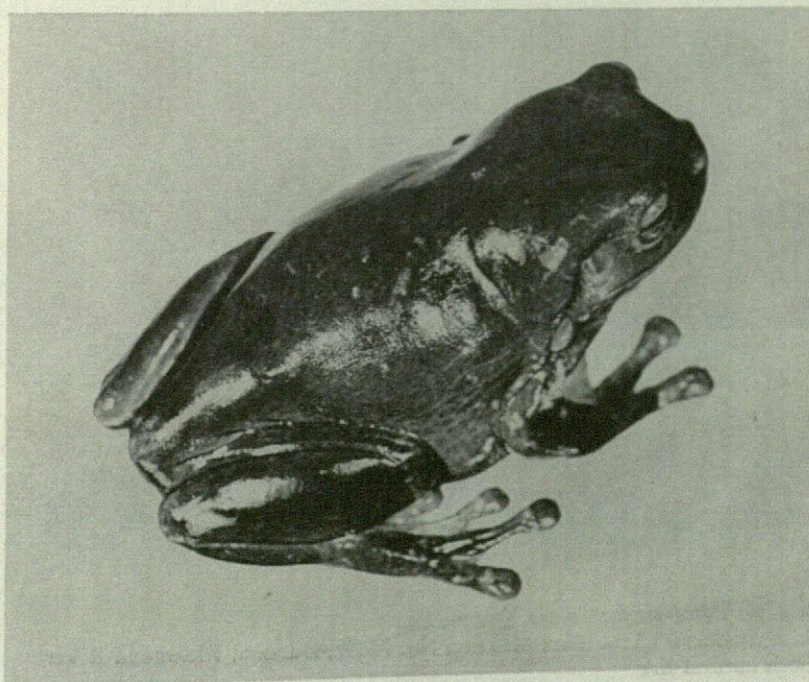
1



2

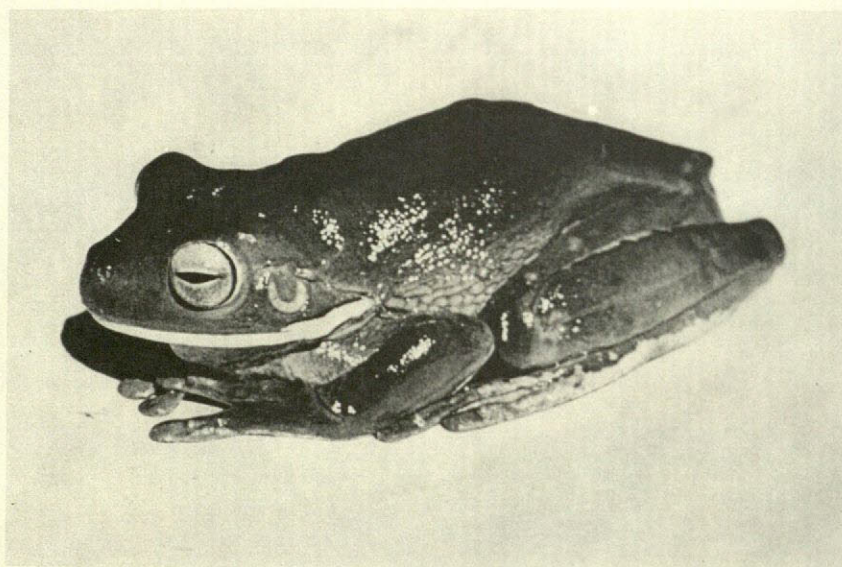


3

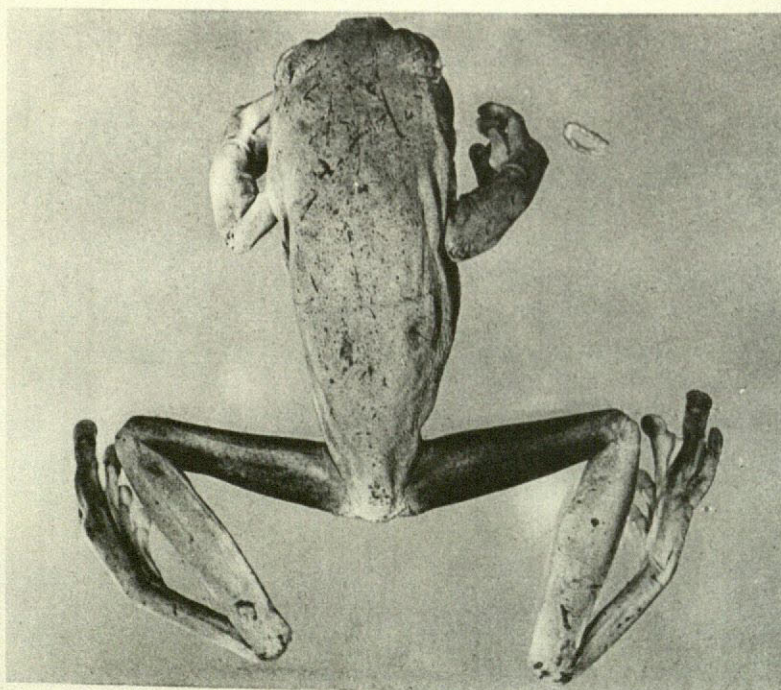


4

1. *Hyla bicolor*; Warrah, near Woy Woy, New South Wales
 2. *Hyla phyllochroa*; Killara, New South Wales
 3. *Hyla gracilentia*; Cairns, Queensland
 4. *Hyla caerulea*; Queensland
- All natural size

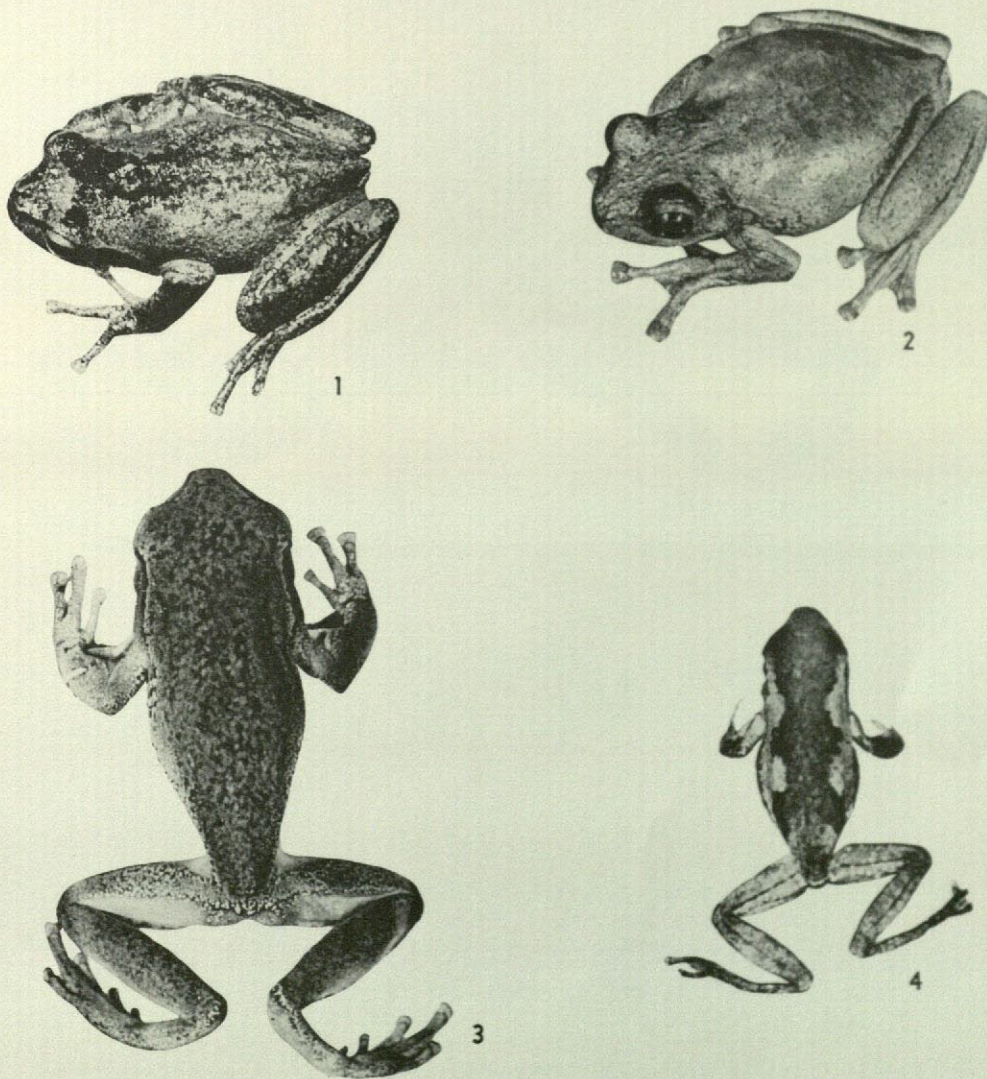


1

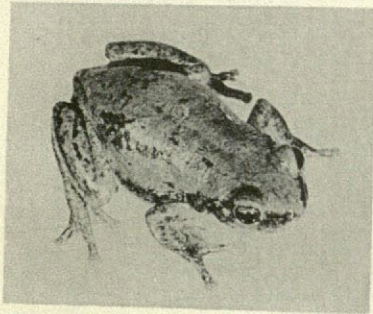


2

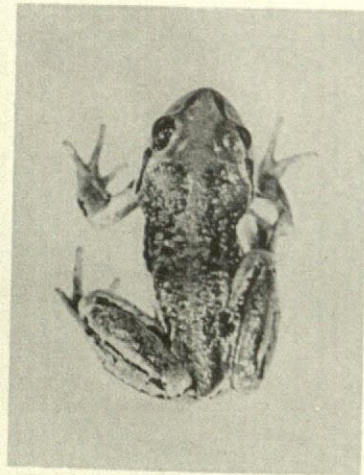
1. *Hyla infrafulva*; Cairns, Queensland
 2. *Hyla chloris* (Australian Museum No. 7485); Dunoon, Richmond River
- Both natural size



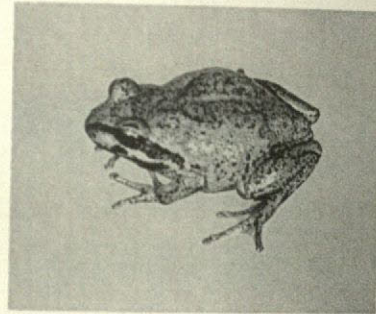
1. *Hyla jervisiensis*; National Park, New South Wales
 2. *Hyla peroni*; Capertee, New South Wales
 3. *Hyla citropa* (Australian Museum No. 5188); Katoomba, New South Wales
 4. *Hyla dentata* (A.M.N.H. No. 63855); 10 miles south of Bellbrook, New South Wales
- All natural size



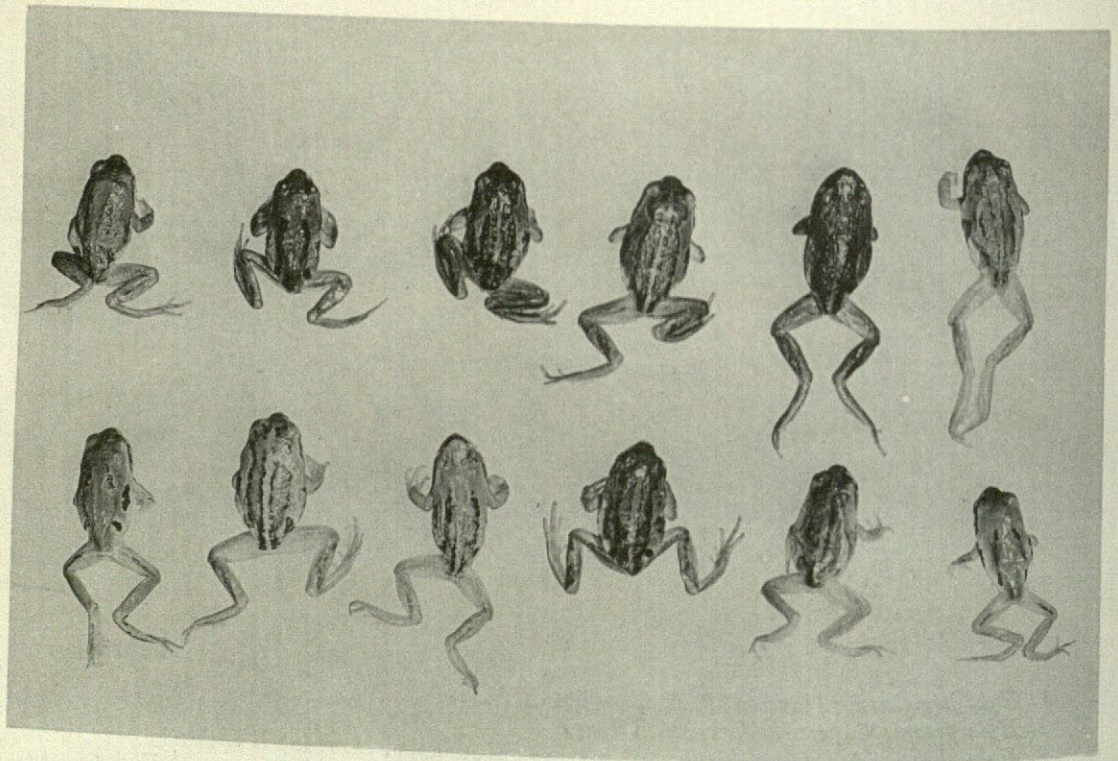
1



2



3



4

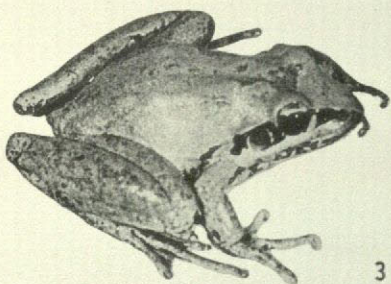
1. *Hyla rubella*; Rainsby Station, near Aramac, Queensland
 2. *Hyla ewingi*; Chalet, Mt. Kosciusko, New South Wales
 3, 4. *Hyla ewingi*. 3. Killara, New South Wales. 4. Juvenile specimens showing variation in dorsal pattern;
 Chalet, Mt. Kosciusko, New South Wales
 All natural size



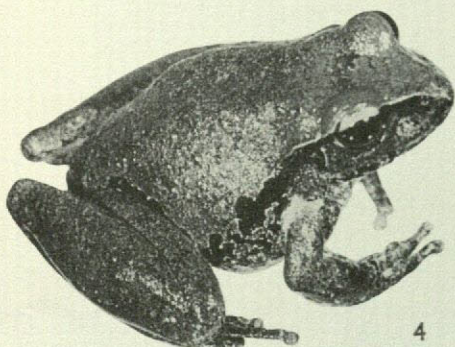
1



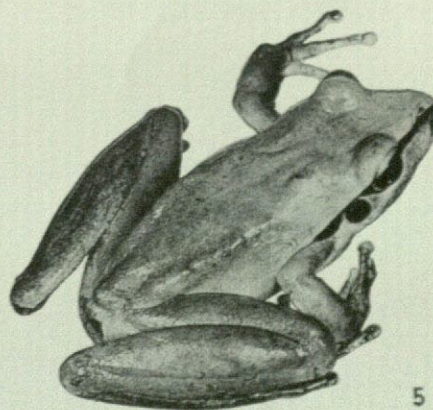
2



3

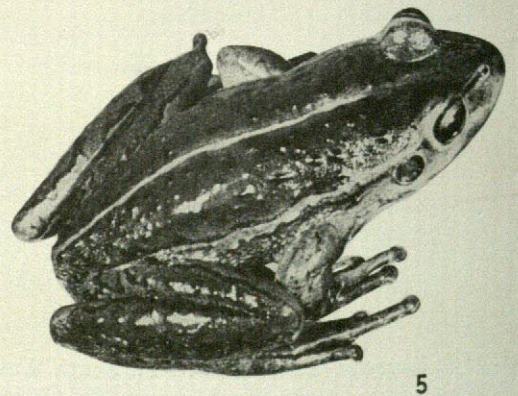
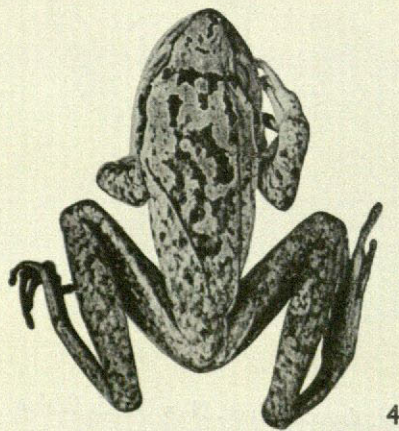
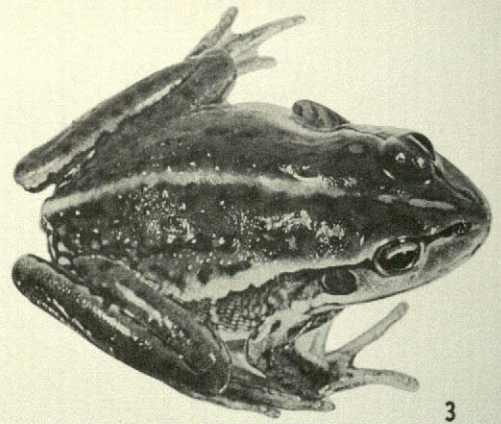
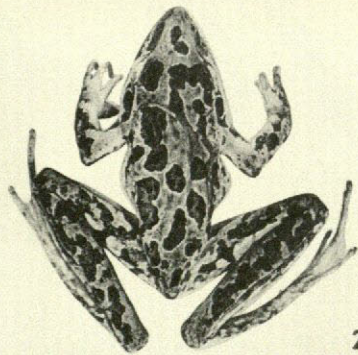
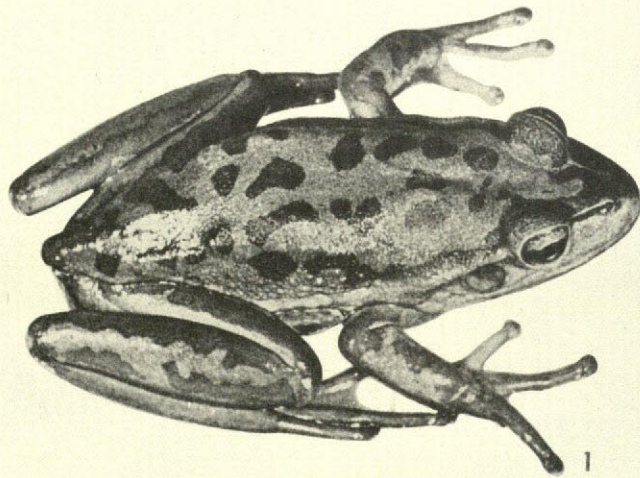


4



5

1. *Hyla booroolongensis*; Ebor, New South Wales
 2. *Hyla nasuta* (Australian Museum No. 6321); Gurravembi, Nambucca River, New South Wales
 3. *Hyla latopalmata*; Prospect Reservoir, near Paramatta, New South Wales
 4. *Hyla lesueuri*; Killara, New South Wales
 5. *Hyla ?vinosa*; Binna Burra, Queensland
- All natural size



1. *Hyla aurea aurea*; East Lakes, New South Wales
 2. *Hyla freycineti* (Australian Museum No. 5687); Lindfield, New South Wales
 3. *Hyla aurea raniformis*; Albury, New South Wales
 4. *Hyla kinghorni* (Australian Museum No. 13818, holotype); Ulong, New South Wales
 5. *Hyla moorei*; Pemberton, Western Australia
- All natural size